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Prof. J. J. Stevenson
10 May 1912

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ON THE

GEOLOGY OF EAST NORFOLK;

WITH

REMARKS

UPON THE HYPOTHESIS OF

MR. J. W. ROBBERDS,

RESPECTING

THE FORMER LEVEL OF THE GERMAN OCEAN.

BY
RICHARD C. TAYLOR, F.G.S.
AUTHOR OF THE "INDEX MONASTICUS."

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ILLUSTRATIONS.

I. Interior Section across the Counties of Suffolk and Norfolk from Harwich to Hunstanton Cliff, showing the position of the Chalk formation in this district.

II. Section and Drawing of the Coast from Harwich to Weyborne Hope, showing the Norfolk and Suffolk diluvial Cliffs, and the Course of the Crag formation.

III. Cross Section from Walton Naze in Essex to Cromer, and continuation thence about twenty miles to Sea, from the Soundings on the Charts. The apparent Course of the Crag is traced upon this Section.

IV. A Section and Geological View of the Norfolk Cliffs, from Happisburgh to near Cley, reduced from the original drawing.

V. An enlarged portion from the original Section of the Cliff, North of Cromer, intended to exhibit some of the remarkable Contortions of the diluvial deposits.

VI. Section of about a mile of the Cliff at Hunstanton, showing the lower Chalk, the Red Chalk, and the inferior Strata. This Section is more particularly described in the Philosophical Magazine for February 1823.

VII. Lithographic drawing of a Fossil Tooth of an Elephant, and portions of the Skulls of Deer—from the Crag beds near Cromer.

ON THE

GEOLOGY OF EAST NORFOLK.

Mr. Robberds's recent publication on the Eastern Valleys of Norfolk, has deservedly acquired considerable popularity, even beyond the limits of the district to which it applies. The circumstances, physical and historical, which it details, are, as well locally as generally, of an interesting character. It is rendered further attractive by the learning, the eloquence and taste employed in the inquiry; and it may fairly be stated to throw some light on a neglected and obscured portion of East Anglian topography. To this gentleman are we indebted for clearing up several doubtful etymological points, in the names of towns and other localities, which the explanations of former commentators had only involved in deeper obscurity. As regards style, the dissertation of this author contrasts to advantage with the dull prolixity of his predecessors, the historians of this county. Moreover, he has called to his assistance the science of geology,—an auxiliary of which those gentlemen never dreamed*.

As an individual, among the many who have derived amusement and instruction from Mr. Robberds's "Observations;"

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* It is not intended to underrate the great merits of the History of Norfolk as a compilation. In every page and sentence, that work exhibits proofs of the laborious researches and extraordinary perseverance of its principal compilers, whose reputation for accuracy of detail has been well sustained through a century of critical investigation. The derivations assigned by Parkins, in his Continuation, are almost uniformly absurd and inapplicable.

having had opportunities for many years of considering the principal geological features of this district, I shall offer, without further apology, a few comments, to illustrate more completely its physical history, and shall supply some additional descriptive portions where it appears desirable, with a view to the consideration of the presumed depression of the German Ocean. I enter upon the inquiry not so much with the views of a critic, as of a cheerful fellow-traveller in the paths of science. Some such investigation appears the more allowable, when it is considered that the Essay of Mr. Robberds is announced as the first only of a series, designed to illustrate the changes which our globe has experienced. The data, therefore, require to be received with caution, if from them, and from a field so contracted, have been drawn the reasoning for more extended speculations yet to follow.

Mr. Robberds shows that these valleys, which are now for the most part solid and productive land, yielding rich pasturage to many thousand head of cattle, were "at no very distant period, arms of the sea, navigated by our forefathers."

The proofs of this change are arranged under two heads: Physical and Historical.

Under the first class are enumerated the connection between the valleys and the German Ocean; the resemblance which their outline bears to the forms generally exhibited by æstuaries and inlets of the sea; and the remains of marine shells and exuviæ discoverable along their margins, at the elevation of 40 feet. These beds of shells are stated to have the following striking and peculiar characters.

"1st. None of them, except a few casual specimens, belong to any extinct or even rare species; but they consist entirely of the littoral shells, which now abound in the German Ocean, and are constantly met with on its shores or in the æstuaries into which its tidal waters flow."

2d. Many of them, particularly the *Buccina*, are still very perfect, and in excellent preservation. 3d. The beds are found at various places, and uniformly at the same height of 40 feet. 4th. They appear, in most instances, not to extend beyond the face of the hills. 5th. They are mixed with vertebræ of small fish, and bones of land animals, decayed vegetable substances resembling *fuci*, fragments of coal, &c.

From these physical circumstances the following conclusions are drawn:—

1st. The shells found either below the soil that fills these basins, or on the sides of the surrounding hills, are unquestionably marine; they were *therefore* deposited by the waters of the sea.

2d. They contain no exuviæ that are peculiar to the older strata, but all resemble those of the testaceous molluscæ now found in the neighbouring ocean; *therefore* the sea, by whose waters these deposits were formed, was the German Ocean.

3d. These beds of shells and other coincident traces of an ancient beach are found about 40 feet above the present surface of the valley of the Yare; *therefore* the waters of the German Ocean once flowed up, and permanently occupied this valley at that elevation.

4th. The valleys of the Bure and Waveney are upon the same level, and communicate with that of the Yare; *therefore* they were at some period connected branches of an extensive æstuary filled by the waters of the German Ocean, to that height at which the traces of their residence may still be discerned.

Historical proofs.—The ancient map deposited in the Yarmouth town chest, of which document an inaccurate copy was published in Ives's *Garianonum*, indicates that many centuries ago, there prevailed a confused notion that these valleys were in earlier times filled by the waters of the sea. Imperfect as is this testimony, it derives confirmation from the remains of anchors which have been discovered in the marshes; evincing the spots where they were found to have been permeable to maritime vessels, since the art of navigation has been known to man. There is further evidence in the sites of Roman forts, most of which the author conjectures, " were built for the defence of this very exposed part of the Saxon shore, against the inroads of those formidable Northern pirates by whom it was afterwards so frequently laid waste." Caister near Yarmouth, and Burgh Castle, generally viewed as the true *Garianonum*, appear to have been the principal frontier posts; and the names and situations of Wheatacre Burgh, Happisburgh, Smalburgh, and another Burgh in West Flegg, seem to refer all these places to a similar origin*.

A dissertation follows on the etymology of the Garienis. Mr. Robberds judiciously maintains, that there are no traces of a *Latin* origin in the term, as applied either to the individual river now exclusively bearing the name of Yare, or to the several openings by which this large inlet is connected with the sea; the most probable origin of the Garienis being the Celtic *Garu*, and thence *Garu-an* (the rough river). In addition to the instances of the Yarrow and the Garonne, recited to prove the prevalence of this name, as applied to rivers in different countries, and under various modifications of language, may be mentioned the names of two mountain streams, the *Garw* and the *Garan*, in Glamorganshire.

In the etymology of the names given by the Saxons to many parts of this district, Mr. Robberds perceives further proofs of the state in which they found it on their arrival. The insulated plots of rising ground, interspersed in the wide part of the valley of the Bure, are still called Holms, the Anglo-Saxon term signifying islands. It is remarkable that the names of nearly all the villages in the Flegg hundreds terminate in *by*, which Mr. Robberds conjectures may be derived from the word *bight* or bay. When the valleys were filled with water, the marginal indentations and recesses would present the appearance of bays, and these sheltered coves would naturally be selected, by maritime adventurers like the Saxons, as the first places on which to fix their abodes. The villages having this termination are all situated adjoining these bights*.

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* Mr. Robberds is inclined, on considering the position of Wheatacre Burgh, to designate it the *Garianonum* of the Romans. Hitherto, but from its name, there has not arisen the slightest circumstance indicative of a station of so much importance at this point. There are no traces of Roman works, nor does the site command the main entrance from the sea.

At Kirkley, ten miles south of Yarmouth, was the ancient haven and inlet of the sea, communicating through Lake Lothing and Oulton Broad, with the wide valleys of the Waveney and Yare. The area which is circumscribed by these valleys and the sea, forming the hundred of Lothingland, still retains its name of *the Island.*

A.D. 1004, Sweyn, as the Saxon Chronicle states, "came with his fleet to Norwich," which he plundered and burned. From the circumstance of this fleet proceeding so far as thirty miles into the interior, it is inferred that this could not have been effected in safety within the ordinary channel of the Yare, but that the whole valley was at that time navigable.

Domesday-book is the next historical document which supplies certain proofs of the sea having entered into the eastern valleys. These proofs exist in the *salinæ*, or saltworks, which are enumerated in many parishes, now distant from the ocean.

The bank on which Yarmouth is placed became firm and habitable ground about the year 1008; but it continued an island, that is, it had a northern as well as a southern channel, as late as the year 1347. From a memorial of the inhabitants it appears, that at the latter period, the main passage at Grubb's haven was silted up; that thousands of acres in consequence of the exclusion of the tide had become good land; and that the inland waters with extreme difficulty forced their way to the sea, through the opposing beds of sand and shingle, almost as far southward as Lowestoft.

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* In process of time, Mr. Robberds conceives, the *by* became synonymous with *dwelling:* which may account for the exceptions to the rule. There are six or seven of these unconformable localities in Norfolk and Suffolk, far removed from sea, marsh, or low valley. The numerous small bays in Lake Lothing, Oulton and other Broads, are provincially called *hams.* Of the forty parishes which skirt the edges of the marshes between Norwich and the sea at Kirkley, a district abounding in similar interior bays, one parish only terminates in *by*, four in *ley*, six in *ham*, and sixteen in *ton*.

In the 13th and 14th centuries, the contentions between the citizens of Norwich and the burgesses of the rival port of Yarmouth, gave rise to certain documents, which are useful in the present inquiry, by showing that to these periods trading vessels sailed up to Norwich, "*the King's Port;* where all foreign merchants paid their customs." The citizens pleaded "that Norwich was a mercantile and trading town, and one of the royal cities of *England*, scituate on the banks of a water and arm of the sea, which extended from thence to the *main ocean*, upon which shipps, boats and other vessels have immemorially come to their market."—"and all this long before Yarmouth was in being, even when the place which that now stands upon, was main sea."

The foregoing recital contains the substance of the evidence adduced to show, "that the eastern valleys of Norfolk were formerly branches of a wide æstuary, and that their present rivers and lakes are the remains of that large body of water, by which their surface was overspread, even in times comparatively recent." After reviewing all these circumstances, the conclusion to which the author arrives is, "that the change here observed is the result of *a depression in the level of the German Ocean itself*, which is now at least forty feet below the height where there is evidence of its having been stationary at some distant period. In summing up, Mr. Robberds conceives that the sea once filled the interior valleys to the height of 40 feet, as marked by the ancient shells;—that the tides flowed at an elevation of 10 or 12 feet, at Burgh Castle, during the Roman occupation of that fort:—that at the Norman Conquest they were only about six feet high:—that there have been in every succeeding century, fewer and less extensive inundations of fresh-water in these valleys:—that old navigators observe within their remembrance, a sensible lowering of the waters in the present channels;—and that all these circumstances combine to mark " a progressive depression in the level of the adjacent sea."—" The rate at which this change has proceeded, might probably be calculated with mathematical precision; the data are rather uncertain, but they seem to indicate that the level of the sea has been regularly falling about eight or nine inches in every hundred years, which would carry back the period of its greatest elevation to about six thousand years ago."

Such are the inferences which the observation of Mr. Robberds has enabled him to form. He proposes hereafter to take a wider survey; to show that throughout this quarter of the globe, there are similar traces of the retiring waves, and that there is evidence of a corresponding elevation of the Indian and Pacific oceans.

In an inquiry of this nature, previously to assenting entirely to certain conclusions, it will be permitted me to scrutinize the " evidence of change," so near home; to examine the data which have led to this conviction, and formed the groundwork of the author's present arguments, and as may be concluded of his future reasoning.

Admitting at once the accuracy of the historical portion of this evidence, it still appears possible to demonstrate, that all the recorded and authenticated changes in the valleys under investigation, since the epoch of the deluge, were effected without any depression of the neighbouring ocean.

A slight preliminary sketch of this district may be useful.

It includes ten principal valleys; all nearly upon the same level, approaching to one plane surface, having the outfall of their collected streams at Yarmouth; there passing with difficulty over the bar that obstructs the haven's mouth. Several minor ramifications, with numerous bays and indentations, almost incircle certain higher lands, forming greater or smaller promontories. Other spots of elevated ground, provincially termed Holms, rise, like islands, from the bosom of these marshy flats. The whole character of the scene is that of an arm of the sea, whence its waters have been withdrawn, or whose bed has emerged from its original level. About 150 square miles, or one hundred thousand acres, are occupied by these valleys; and in traversing them, on the causeways by which they are now intersected, one is reminded of those similar but more extensive tracts of low lands on the opposite coast. The general width of the river Yare is about 150 feet; and of the Waveney and Bure 100 feet each. In their winding courses they frequently expand into or communicate with small lakes, locally termed Broads. There are upwards of sixty of these broads; besides as many smaller pools. Their depth varies from 15 to 30 feet, and they differ in extent, from one acre to 1200; that of Breydon being the first, and Lake Lothing the sixth in magnitude.

It may not be irrelevant to state, that the drainage of the greater portion of Norfolk and part of Suffolk, is effected by means of Yarmouth haven. The summit or highest edge of this area of drainage, extends to within seven miles of the sea at Snettisham, on the opposite side of the county. Within these limits is comprised an area of 1200 square miles in Norfolk, and 220 in Suffolk. Consequently, the quantity of water collected in, and passing out of, so extensive a basin is considerable. In connection with this subject is the geological fact, that these limits of drainage singularly correspond with the boundaries of the great deposit of clay, brick-earth and diluvial matter, resting upon the chalk, in this portion of Norfolk.

The most material circumstance now to be inquired into, is the presumed occupation of the eastern valleys, to the height of 40 feet, by marine waters, at an indefinite period, subsequent to the deluge. The authority for this supposition appears to be solely found in the beds of marine shells, which are exposed at that elevation, along the sides of the Norwich valley. These shells are described as strictly similar to those of the testaceous molluscæ now abounding in the adjacent sea, and continually met with upon our shores. Upon this apparently strict conformity to the genera of present times the conclusions of Mr. Robberds are obviously founded: but I conceive, if it should appear that these exuviæ are more properly assignable to an æra preceding the deluge which last affected our earth, that gentleman will consent to abandon the views he at present entertains.

It happens that a catalogue of the stratified shells of Bramerton, the principal source in this neighbourhood, whence Mr. Robberds, Mr. Sowerby, Mr. W. Smith, Mr. Leathes, and others have derived their specimens, was not long since communicated by me in the Geological Society's Transactions. From this list, which is capable of extension from subsequent discoveries in the minuter genera of shells, naturalists are enabled readily to determine, whether such do in reality belong to the class of living shell-fish; or, if otherwise, what are the proportions it exhibits between those which appertain to the recent and the extinct species. Nearly the whole of the shells contained in this catalogue are accurately figured in Sowerby's Mineral Conchology, from specimens collected at this spot; and all are unquestionably similar to those which characterize, and are peculiar to the *crag;* or, as it is properly called, the upper marine formation. It is extremely probable, that upwards of one half of those enumerated have no recent analogues, and the practised eye of a skilful conchologist will detect varieties in many that appear to assimilate to those now living. At the same time it must be remembered, that they are associated with the remains of herbivorous animals, which have never been known in the present state of our globe,—the mastodon, the elephant, the gigantic elk, and the enormous horned bison. Their regular beds contain no works of art; no traces of the human species*. The British Museum contains a tooth of the mastodon, in which the enamel is converted into opal. This fine specimen is figured in Smith's "Strata Identified," and was discovered with horns of deer, at Whitlingham, in that same stratum of crag shells, described by Mr. Robberds†.

In general, the fossils of this formation are not mineralized, but are very fragile. In Suffolk and part of Norfolk they are chiefly deposited in dry loose beds of sand, which are slightly consolidated and discoloured by iron. Thus at Languard Cottage, some curious artificial caverns have been formed in a thick bed of these shells. Where they occur in clay, they are partially mineralized; their surfaces are smooth, and sometimes glossy. At Whitlingham and upon the north-west coast of Norfolk, they are occasionally seen resting immediately upon the chalk, mixing with its flinty debris, and even having their cavities filled with chalk. Horns of stags are frequently found under the same circumstances, embedded in chalk marle, particularly along the sides of the Norwich valley, extending between Hellesdon and Cantley. In Essex, similar shells occur in a strong blue clay. Near Orford, in Suffolk, they are mixed with interesting varieties of coral and sponges, forming a soft porous rock used for building. In some other parts of its course this formation assumes the appearance of a gray sandstone; in others the shells are detected in an extremely hard clay-stone; but instances occasionally occur where organic remains are altogether wanting.

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* The rudely-shaped flint axes which have been discovered in the peaty bed of the Waveney Valley, are among the most ancient monuments of man in this island. They must be classed with the extraneous alluvial substances of our highest valleys.

† I abstained from noticing among the organic remains that have been occasionally observed in the tertiary deposits of this district, those of the whale. I have certainly seen large specimens, from several different points, which were stated to have been discovered under circumstances similar to those in which the bones of land animals and smaller fish are found. But I am assured by Dr. Buckland, that the bones of whales do occur, and that he identified a fragment amongst the crag of Bramerton or Whitlingham, in the year 1824. A caudal vertebra of a whale, which is decidedly fossil, viz. antediluvian, has just been presented to the Geological Society, from Norfolk.

In remarking upon the absence, at Bramerton, of a particular shell, which is met with among the crag fossils of Harwich, Mr. Robberds considers that this circumstance alone is fatal to the opinion entertained by me, of the continuity of the formation. But it must be remarked, that it is characteristic of the shells and other organic bodies deposited with the crag; that they are by no means diffused in equal numbers and proportions throughout, as in some older strata; but occur at intervals, in groups and genera. Thus at Cromer the predominant and remarkable shells are *Mactræ;* at Runton, *Cardiæ;* nearer Cley, *Murex striatus;* at Bawdesey cliff, *Murex reversus*, and *Pectunculus;* at the Beacon, *Venus æqualis;* at Felix Stow, *Pectunculus* and *Voluta Lamberti;* south of Languard Cottage, *Murex contrarius*, *Cardiæ*, and *Mya lata:* at Bramerton and near Norwich are *Murex striatus*, *Tellinæ* and *Balani.* The absence, therefore, of one or of many species from any of these localities, cannot weaken the remaining concurrent evidences that identify this formation, nor can it lead to the confounding it with any other.

The shells of Bramerton, and other parts of the Norwich valley, consequently, belong to the crag formation, and are not an assemblage simply of the recent species which abound in our seas, although they are mixed with many that closely resemble the existing varieties.

Mr. William Smith, than whom a better practical authority on this question cannot be quoted, states that "through Norfolk the crag shells lie near to, or are in contact with the top of the chalk; and *under a loamy soil*, on or near some of the best land in Flegg and the Vale of Aylsham."

On the contrary, Mr. Robberds's experience goes to prove, —and without it his views of the flowing of the ocean tides through the Norwich valley at 40 feet elevation, cannot be sustained,—that the shells so far from being stratified, form only a beach or belt, in no case penetrating into the sides of the hills. That this may be partially and occasionally the case, it is by no means here intended to doubt, particularly after the positive investigation to which this point has been subjected. There are difficulties in discovering a vein of coal or a bed of iron-mine, even in the exposed face of a rock or mountain: how many impediments prevent the tracing any thin or soft stratum, in a highly cultivated country, thickly overspread with diluvial and alluvial substances! Norwich is nearly upon the western boundary of the regular deposition of crag: the few detached indications that are observed further in the interior valleys, seem rather to denote its antediluvian limits. Consistently with what is observed elsewhere, this deposit becomes thin and imperfect at its western edges, which have evidently been operated upon by diluvial agency. The high lands and the great accumulation of diluvium on each side of the principal valley, render examination difficult: the chalk itself rises above the level of the highest crag deposits; —the phænomena attendant on the sinking of deep wells are seldom observed or recorded; and it is chiefly on descending again into the other valleys of this district, that fresh proofs, more or less positive and abundant, present themselves.

Experienced well-sinkers, however, do affirm, that on forming deep wells, in various places around Norwich, at a distance from the river, they have occasionally encountered a stratum of shells overlying the chalk. In one instance, at a farm upon Mousehold, the depth perforated was 132 feet, of which the first 88 consisted of diluvial gravel and sand; then a bed, two feet thick, of conglomerated crag shells, consisting of *Murices*, *Cardiæ*, *Tellinæ*, and *Patellæ elongatæ*, immediately lying upon the chalk. Here, therefore, was absolute proof of a continuous shelly bed, extending beneath nearly 90 feet of diluvium to a considerable distance from its outcrop in the Norwich valley.

At Marsham, and in the adjacent vales, it is again discoverable, accompanied with many bones of animals, large vertebræ, and horns of deer.

Further north, at Aylsham, on sinking a well in 1824, at the depth of 60 feet, a bed four feet thick of crag shells, was met with. They consisted of the genera *Murex*, *Turbo*, *Natica*, *Mactra*, *Venus*, and *Tellina*.

On reaching the coast at Cromer, they are again observed at low water embedded in a sandy ferruginous stratum, resting upon the chalk. Along the whole line of this coast, extending from near Cley in Norfolk, to the Naze in Essex, in an extent of one hundred miles, this formation has been minutely and almost uninterruptedly traced, by myself. The result of this investigation has been fully confirmed by able geologists, in various portions of that district. (See Section II.)

The remains of certain animals have been so often observed accompanying the crag, that they may be considered as indicative of its extent even when other proofs are not attainable. Fragments of bones, teeth, skulls, and horns are repeatedly met with by the fishermen, when dredging for oysters at sea. So abundant are these animal remains on the oyster banks opposite Happisburgh, that they are frequently drawn up in nets.

Further arguments in proof of identity and general continuity,—the two great facts which it was essential to establish, as applied to this formation and the theory of Mr. Robberds, —are, it is presumed, unnecessary. The supposed course of the crag formation across Norfolk and Suffolk is traced in Section III.

Some notices of the prevalence of fossil bones upon the eastern coast have appeared in the Philosophical Magazine, and Geological Transactions. To those enumerated might now be added many subsequent discoveries. I am happy in having been instrumental in attracting the attention of several observers to these phænomena. Since the year 1822, many interesting well-preserved specimens have been collected upon the beach between Winterton and Cromer, where heretofore they continued unregarded. It is useless to occupy these pages with a detail of localities; for in fact, traces are discernible at every mile. By far the greater number of specimens have been derived by means of the fishermen: a circumstance that confirms the opinion before given, that a considerable accumulation exists on some of the outer banks off this coast. Viewing these scattered fragments as the relics of those animals who once inhabited the surface of the upper marine formation, who roamed along the antediluvian shores and æstuaries, and fed amidst the forests of a former world,—how numerous are the proofs here assembled!

A detailed account of these deposits cannot but be instructive, and will be best supplied by those who have frequent opportunities for observation. There is some reason to hope that this information will be furnished by a reverend gentleman of East Norfolk, who possesses ample materials, and the ability to promote the science of which he is an admirer.

Let me be permitted to add here one word on the services which the establishment of a provincial museum at Norwich has already rendered, by furthering the progress of local geological discovery, by increasing the number of labourers in the field of science, and by furnishing a public depository of those interesting objects, which illustrate the structure and former condition of the surrounding district, and attest the revolutions to which it has been subjected.

In tracing the leading superficial features of East Anglia, it will be observed, that the general dip of the strata is towards the south-east, forming an angle of inclination, amounting probably to not less than 600 feet. At Harwich the upper surface of the chalk was reached at 64 feet *, and on the north-west coast, beginning at Hunstanton cliff, the inferior strata rise to the surface. The top of the chalk being sunk as much below the sea at Harwich as the bottom is elevated above the sea on the north-western escarpment, and its entire thickness being estimated at about 400 feet, the slope will be somewhere as above suggested. This will be best understood by consulting the Section No. I.

It has before been remarked, that the principal drainage of Norfolk, comprised within that portion which is covered by diluvial clay and loam†, conforms to the slope of the chalk, and passes its collected waters to the sea at Yarmouth. In like manner the drainage water of nearly four-fifths of Suffolk, including the great clay district, conducted by several channels towards the south-east corner of that county, there enters the ocean.

Imagine the general plane of the chalk, as it sinks to the

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* Borings were continued in the chalk at this place, 293 feet more.

† I adopt the term *diluvial*, now in general use, to indicate the water-worn debris resulting from the deluge; as distinguished from the *alluvial* deposits which proceed from causes yet in operation.

south-east, once divested of its diluvial covering. The line at which this plane would be intersected by the ancient ocean, defines an irregular area, which is precisely that occupied by the crag formation.

It is unnecessary to enlarge, in detail, upon the geological minutiæ of this district, but it is essential to our subject to consider its principal characters.

All admit that the chalk, more than any other formation, exhibits the powerful effects of immense currents, sweeping over its surface: that valleys have been hollowed out, and eminences formed, and a large portion of this island covered with its debris. From the variety of strata, some even of fresh-water origin, which occupy certain positions above the chalk, it is evident, that at distant intervals, considerable geological changes, more or less extensive, were effected. The imbedded vegetables, the zoophites, the shellfish, and the animals change with each deposit; the old series become extinct, and new ones in their turn become documents attesting geological epochs;—the unerring records of successive æras:—medals stamped, not with specific, but with relative dates.

The stratum of marine productions, under the local name of crag, has its assignable and comparative date; its inhabitants were the last that occupied the waters and the ancient shores, prior to the catastrophe which affected this part of our globe, and to the reforming from its wreck that surface on which man has fixed his abode and covered with his species. This crag rests in part upon the London clay, and a laminated clay without fossils, perhaps the plastic clay, and partly upon the chalk, occupying the lowest sites; rarely rising to 80 feet above the present level of the sea, and in general not more than half that elevation. The average level of its base may be considered to be about that of the present ocean. In certain cases, where the chalk hills attain a higher level than the crag, that deposit could only be expected to envelop or surround their sides, and not to penetrate *into the chalk.* Such eminences would then present the appearance of tongues or promontories of chalk, protruding into the crag; and this circumstance accounts for the occasionally apparent absence of that formation.

But the crag itself has, at the last of the geological epochs, been subjected to abrasion by the diluvial currents to which allusion has been made. Portions, probably from its western edges, have been swept away. Their fragments, mingled with those of the chalk and preceding formations, piled in enormous heaps, form the cliffs of Cromer and Trimingham 250 or 300 feet in thickness, upon the original crag, which rests, *in situ,* at their base. The proof of the disruption and transportation of more ancient strata, may be observed in the enormous detached masses of chalk, in these diluvial cliffs, at various elevations *above* the crag. Near the light-house hill at Cromer, one of these insulated patches is 150 feet high, and has a kiln upon it, in which lime of an excellent quality is burned. Further on, at Runton, is a large mass 80 feet thick: another rises to the height of 100 feet; and at Sherringham is another still higher. In all these cases, they rest *upon* the crag, proving alike the breaking up of the older strata and the continuity of the later. (See the Section No. IV.)

We have yet to consider one remarkable accompaniment of the upper marine formation, upon the Norfolk coast. This consists in that apparently continuous bed of vegetable substances, with which the crag is frequently in contact, at an irregular elevation; sometimes above and sometimes below the high-water line. This coincidence had been remarked, in 1822, along about 25 miles of the coast; but it was more obvious after the unusually high tides, in February 1825, had carried away large portions of the cliffs, leaving the woody stratum exposed. At some points this bed consists of forest peat, containing fir cones and fragments of bones; in others, of woody clay; and elsewhere of large stools of trees, standing thickly together, the stems appearing to have been broken off about 18 inches from their base. They are evidently rooted in the clay or sandy bed in which they originally grew, and their stems, branches and leaves, lie around them, flattened by the pressure of from 30 to 300 feet of diluvial deposits. It is not possible to say how far inland this subterranean forest extends; but that it is not a mere external belt is obvious from the constant exposure and removal of new portions, at the base of the cliffs.

Doubtless this must be the southern extremity of that submarine forest, which has long engaged the notice of geologists, on the north-west part of Norfolk, whence it is traced across the Wash, and the fens of Cambridgeshire to Peterborough, and all along the Lincolnshire coast, as far as the Humber. There is no important variation in the general level of this woody tract. As relates to the Norfolk portion, it appears so closely in connection with the crag formation, as almost to form a part of it: the shells of the one being occasionally mixed with the vegetable matter of the other; and are further accompanied by bones of stags, elephants and oxen.

An obvious similarity exists between the deposits on the Norfolk coast, and those in the district between the Humber and Bridlington bay. The same diluvial accumulations; the same description of large bones of animals, of shelly fragments; of crumbly slipping cliffs; of subterranean forests at their base;—the same traces of plastic clay above the chalk, and rolled masses of primitive rocks mixed with the alluvium, attest the contemporaneous origin of the Holderness district with that more immediately under consideration. Dr. Alderson, in describing the geological characters of that district *, many years ago, was of opinion that the diluvial hills were

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* Nicholson's Philosophical Journal, 4to, vol. iii.

heaped upon the submarine forest. Nothing has arisen to discourage that idea; but it derives confirmation from the parallel case which is presented by the cliffs of Norfolk.

On the first view of this extensive subterranean or submarine forest, one is inclined to inquire whether it be not contemporaneous with the freshwater formations observed elsewhere above the chalk? Hitherto no freshwater shells have been observed imbedded in this deposit on the Norfolk coast; but they have been seen at Harwich, and in the clay cliffs of Essex; and fluviatile shells abound in the forest peat of the fens of Lincolnshire.

Limiting our observation at present to these sites of ancient woods and beds of peat on the east coast of this county, we perceive that they are so variable in position, so undulatory, so often concealed by diluvium, so changeable in their appearance through every modification of woody clay and gravel, peat and beds of forest trees, that it is often difficult to determine whether their real position be above or beneath the crag. Certainly, near Cromer, the trees are a few feet above the crag stratum, and are about the level of high water.

Perhaps the most probable conclusions, to be derived from a consideration of all these circumstances, are these:—

That after the formation of the chalk, the waters deposited the marine exuviæ, and gave existence, during the long period in which they occupied that portion of the former surface, to those remarkable accumulations of crag shells which we now witness.

That the trees and vegetables covered various parts of the surface of this new formation after it had become consolidated.

That in this state, these woodland tracts afforded shelter and support to certain animals, whose traces we find both amongst the vegetable deposits and in the drifted heaps containing marine substances.

Finally: All were buried in one common catastrophe. The same eruption of the waters that overthrew the pines and forest trees, destroyed the herbivorous animals, and buried the crag shells, beneath the ruins of more ancient strata.

In a preceding paragraph of this paper a proof of the violent irruption of the strata is exhibited in the enormous detached masses of chalk, lodged in the diluvial cliffs and occupying a position *above* the crag, which is seen distinctly stratified, reposing upon the plane of the original or main body of chalk.

An examination into the materials of this range of cliffs will introduce to our notice more ancient formations, whose traces are not here so readily accounted for. The shore to the west of Cromer exhibits a singular accumulation of travelled fragments of primitive rocks, whence it would not be difficult to collect a tolerably illustrative series. They consist chiefly of rounded blocks of several varieties of granite, basalt, porphyry, trap, and micaceous schist; sandstones of various kinds, chert, breccia; besides limestone, claystone, &c. I am not sufficiently acquainted with the nomenclature of rocks to hazard a more detailed enumeration here. The diluvial fragments of the later series are from the chalk, the plastic clay, London clay, green sand, Kelloway's rock, the oolites, lias clay, and marlestone;—in fact, almost every formation above the coal measures. These are of all intermediate magnitudes, up to four tons weight. Large bouldered masses may be seen in the sea at low water, lying mixed with flints, upon the chalk. One block of granite was observed near six feet in diameter. Another mass standing six or eight feet high, has for years been known to the fishermen under the name of Black Meg. This collection extends about two miles, chiefly opposite to Beeston Hills. At Happisburgh Cliff the blue diluvial mud or clay appears to contain rolled fragments of various primeval and secondary rocks. Among them have been observed granite, basalt, sandstones, black siliceous pebbles, septaria, and micaceous schist containing small garnets.

Whence has this singular assemblage been derived? Certainly not from ballast; the size of many of these stones prevent that supposition, as does the locality of their position. Had they drifted from our northern continental shores, as has been suggested, one would expect to find them dispersed generally along this coast. But the question appears decided by the fact that they are chiefly, if not entirely, supplied by the diluvial clay in which they may frequently be noticed, whence I have collected many specimens, and others may be seen several miles inland. It is probable that these large masses, after being dislodged from the cliffs, are very little removed from their original sites by the action of existing currents in the ocean. This opinion is confirmed on considering the other circumstances attendant on the wearing away of these cliffs. As might be expected, the alluvial substances that form the beach and line the shores of the eastern counties, are, for the most part, obviously derived from the small rounded fragments, and the ancient water-worn gravel, which the sea has washed from its precipitous borders. But there remain extensive portions which do not appear to have changed their position, further than would be occasioned by the dissolution of their matrices. These instances occur, with few interruptions, in a course of 12 miles, from Mundesley to Salthouse Bay, and in particular at Foulness. A series of irregular ridges of unrolled angular flints, locally termed *rocks*, mark the ancient sites of denuded chalk beds, and prove valuable barriers by checking the violence of the surf in northerly gales. No change in the forms of these ridges of chalk flints is perceptible. The ocean, mighty and furious as it sometimes is, will partially overspread them with sand, but is incapable of shifting the heavy interlocking materials which offer the only permanent obstacle to its encroachments.

As regards the boulders of miscellaneous rocks, it may be observed, in concluding that portion of our subject, that they occur chiefly upon the beach and sloping shores; not on those external ridges over whose sharp irregular surfaces they can scarcely be imagined to have rolled.

Whilst reviewing the geological phænomena attendant on the eastern coast and valleys, we must not lose sight of those which are observable in their upper extremities and ramifications. These are lined, not with an oozy sediment as in the æstuaries, but with moor and forest peat, to the depth of six or seven feet. In the operations of cutting drains and turf, the horns of large ruminant animals have been discovered; and in the gravelly margins occur vertebræ and teeth of elephants. There is a considerable deposit of peat in that valley in which the Waveney and Little Ouse have their sources; and trunks of trees, whose wood is yet hard, are sometimes taken out and used as fuel. Horns of deer are occasionally met with in the fens of Lopham, Hinderclay, Redgrave and Bressingham. It is an interesting fact also, that in the peaty valley of the Waveney, at Roydon, Diss and Hoxne, have been found ancient flint axes. Teeth and large bones prevail in the diluvial gravel of the same valley at Hoxne and also at Eye. Vertebræ occur in another branch near Botesdale, and in some valleys on the eastern coast of Suffolk.

The gravel of the Bure valley has furnished many animal remains, as also have the banks of the Wensum. Mr. Parkinson long ago observed that this district supplied a greater abundance of fossil bones of deer than any other part of this kingdom.

But the most considerable discovery was very recently made, in a valley near North Walsham, in the process of digging an extension of the Dilham Canal. These specimens have, by permission of the Canal Company, been deposited in the Norwich Museum. They consist of horns of two species of deer, and skulls apparently of the fossil auroch or bison, and of the common ox.

It will be observed, that the localities which are here recited, are all within the limits which may be assigned to the crag; and it must be added that in frequent instances they are accompanied by decided traces of that formation. Although they are comparatively remote from the sea, their sites are not more than 40 to 80 feet above its level. The ancient stone axes and other implements found in the peat of the Waveney valley, denote its alluvial covering *. Some of the

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* The Waveney valley has exhibited traces of the early occupants of this district in greater abundance, and more generally distributed, than any other portion of East Anglia. From Garianonum even to Thetford (the ancient Sitomagus), coins, medals, urns, and other reliques of Roman origin, have been found at numerous points; indeed in almost every parish bordering upon this valley,—indicating it to be a favourite position with that people. Many local circumstances concur to render the occupation of this valley desirable to the adventurers of various nations, who from time to time penetrated into the interior, through one or other of the channels of the Garienis. At Thetford, and at several points near the upper part of the Waveney, Celtic and Scandinavian remains of military weapons have been discovered. Flint axes and copper celts have been found in the neighbouring parishes of Roydon, Diss, Scole, and Hoxne. The stone axes appear to be similar in form to those to which the original Teutonic appellation of *Staimborts* or *Steinbartes* is given by Dr. Hibbert, occurring in Orkney and Shetland.

They have also been met with in the vicinity of the Humber, near the confluence of the Trent and the Ouse, being probably brought hither by the Saxon and Scandinavian pirates that from the earliest period infested the shores of this country. A comparison of the forms of these ancient weapons, the substances of which they are constructed, and the circumstances under which they are discovered, aided by the scanty historical materials hitherto collected, is necessary to determine their origin with any degree of precision. This is a task which, I believe, antiquaries have not hitherto attempted. The copper instruments of war are observed chiefly in those districts which were occupied by Celtic tribes. As regards the stone axes, the authority alluded to, states, that in whatever country of Europe weabones probably belong to animals who fed and died in those situations; while others appertain to species that were extinguished by the last catastrophe which affected our earth.

In two other moory valleys within the diluvial district of Norfolk the horns of stags have been found: the one at Carbrooke, near the head of the Stoke river; the other at East Bilney by Dereham, communicating with the Wensum valley.

pons similar to them might be found, a visitation from the Vikingr, or Sea-kings of the North, is strongly indicated.

Having obtained certain data, approximating to chronological accuracy, we shall thence be enabled to observe, with some precision, the time occupied in forming alluvial depositions, since those early traces of man, those rude works of art, were deposited in our valleys and morasses. The canoes, the implements of war and of commerce, the works and the personal ornaments, both of the aboriginal inhabitants and their successive invaders, are occasionally exposed or raised from beneath extensive peat formations in this island. They are, indeed, the only criteria by which to mark and measure the extent of this alluvial process in given periods, and in particular situations, during the succession of ages which have elapsed since the surface of our soil was habitable to man. From the many instances which have occurred of these geological chronometers, two only will be selected as bearing more immediately upon the main topic of this paper, and but little removed from the district under consideration. In the marshes of the Medway, which nearly resemble those of East Norfolk, several canoes were dug up, in 1720, in all respects similar to those which are ascribed to the ancient Britons; being composed each of a single tree, hollowed by fire, precisely in the same manner as those of the North American Indians.

The other instance is the Roman Causeway, supposed to have been made by the Emperor Severus, extending from Denver to Peterborough, across the Fens of Cambridgeshire. It was composed of gravel three feet deep and sixty feet broad, but is now covered with moor or peat from three to five feet in thickness. In both these cases, particularly in the latter, evidence is produced of an *increased elevation of surface*, and the gradual formation of solid land, either by the deposition of oozy sediment, or by the growth and decay of vegetable substances; and data are supplied, as in the case of the ancient anchors in the Garienis, for measuring the extent and duration of that process.

From all that has been said in the foregoing pages, it will appear that the fossil bones occupy no specific place in the upper marine formation. They are found equally lodged in the higher valleys as at the lowest point to which the sea retires, and even on shoals some miles from the shore; and though frequently unaccompanied by crag shells, are most commonly blended with them. Sometimes they rest, in good preservation, in ancient peaty depositions, or lie, as if thrown by currents, amongst heaps of marine shells; and in other cases, broken and partially rounded, they are imbedded in diluvial gravel.

We can therefore only conclude that the existence of those races was equally contemporaneous with the crag and with the buried sylvan tract at the base of the cliffs, and that it ceased at the epoch which invested the whole with their diluvial covering.

That the crag shells and their accompaniments form a comparatively local deposit, like some other formations, is evident. Its existence and its peculiarities, nevertheless, indicate a distinct geological æra.

Let us recapitulate the remarkable facts, by which, in this case, the questions of identity and general continuity are determined.

A district, bordering a hundred miles upon our eastern coast, is occupied by an ancient marine deposit, continually changing its aspect, yet constant in its peculiar characters, and always to be understood by unerring data: now appearing as a ferruginous sandstone, then in compact clay, and again considerably indurated; sometimes blended in a mass of extinct zoophites, sponges and alcyonites, forming a soft rock; oftener an irregularly accumulated mass of decomposed and broken littoral shells, loosely imbedded in sand like an ordinary sea beach, yet accompanied with the remains of unknown animals. Sometimes forming the substratum of a considerable area; or, overwhelmed beneath the debris of older strata, only detected at intervals. At one point exhibiting groups of shell-fish allied to those of the neighbouring sea, and at another composed of numerous genera, which are neither to be recognized living in any part of our globe, nor assimilating to the fossil shells of other formations. Can it be doubted then, that we must look to an earlier epoch in the geological history of our earth; to a period prior to that in which our diluvial eastern counties received their existing shape and covering; and to other, but not less extraordinary operations upon their antediluvian surfaces, than those to which Mr. Robberds's views would limit us, in accounting for the phænomena to which he invites our attention, and of which I cannot but consider an erroneous application has been made?

I have been led to introduce this sketch of the most remarkable deposits above the chalk, because they have been hitherto neglected; and because it was desirable to elucidate, with precision, the geology of the limited district to which these observations are directed,—so far, at least, as it bears upon the assistance which the phænomena it exhibits have afforded to the peculiar views of Mr. Robberds. At this stage of the inquiry, conclusions incompatible with those views are unavoidably suggested by a consideration of the data here supplied.

Enough has been advanced, to withdraw from inferences, apparently so unobjectionable, the very basis upon which they are founded. May I not here be allowed to register those premises and those conclusions which, after a careful oryctological examination, appear opposed to those of Mr. Robberds?

The shells which are deposited at the height of 40 feet, on the sides of certain valleys, belong to an antediluvian formation; *therefore* they cannot be admitted as evidence of supposed changes, or of events that have occurred subsequently to the deluge.

There is no direct or reasonably inferred proof remaining of the postdiluvian operations of the sea at such an elevation upon our coasts; *therefore* the assumption that the German Ocean was 40 feet higher than at present, and has gradually fallen, is unsupported.

That at an early period of what may be termed, in geological phrase, the existing state of our globe, the sea entered the mouths of these æstuaries, and rolled its tides far up into the interior, I can no more doubt than the respectable authority, who has collected so many indisputable proofs. The difference, and that no trivial one, between us, lies in the amount. I differ as regards the quantity and elevation of the tidal waters, *after their admission into these valleys;* being satisfied that such elevation was inconsiderable, and that in no sensible respect were the waters of the surrounding ocean, since the existence of man upon this island, higher than at the present moment.

To render this more intelligible, it is necessary to trace the causes of the change in the level of the inland waters, and of the bed of the valleys themselves, to their probable origin; commencing from the period at which it is proved that such flats openly communicated with the sea.

The set of the great tidal current of the German Ocean is from the North-west, along the eastern shores of this island. It consequently happens, that wherever any portion of the land projects beyond the general line of coast, and consists of any material which yields to the action of those tides, such exposed points have, from the earliest recorded periods, been gradually reduced and rounded off, and the debris has been uniformly deposited to the southward; either forming shoals in the sea, or elevating low tracts of land upon its borders. Thus the detritus of the chalk strata at Flamborough Head and the diluvial cliffs of Holderness have contributed, in the slow progress of years, to increase the alluvial districts near the Humber. In their progress southward, the tides next meet with an extensive obstruction in the projecting county of Norfolk. About twenty miles of its coast has been subjected, from time immemorial, to the abrasive action of ocean currents. The ancient villages of Shipden, Wimpwell and Eccles have disappeared; several manors and large portions of neighbouring parishes have, piece after piece, been swallowed up by the encroaching waves; and their site, some fathoms deep, now forms a part of the bed of the German Ocean. Cooperating with the tides, the land springs in the bordering high grounds are constantly, though slowly, working to reduce our boundaries. Enormous masses, dislodged by the pressure of the springs, are continually precipitated upon the beach from the high cliffs, to be carried off by succeeding tides. In the winter of 1825, one of these fallen masses covered twelve acres, extending far into the sea; its upper portion having fallen from a height of 250 feet, near the light-house at Cromer. The effects of this destructive process are traced in the banks and shoals extending 20 miles to the southward, and in the formation of the low flat tract between Happisburgh and Gorleston. In their progress the tidal currents possess sufficient strength and velocity to preserve a deep channel, locally called Roads, parallel with the shore; but they deposit, both on the sea and land sides of this passage, the alluvial matter with which the waters are charged. Mr. Cubit has appropriately denominated this channel, a sea river. A portion only of the substances that form the shoals and sand-banks may be considered shifting, and these are modified by every variation of wind and tide. The nuclei of most of the largest appear to be permanent, and probably existed at a period far more remote than we can estimate. Thus the antiquity of the Holm-sand, opposite Lowestoft, is decided by its Anglo-Saxon name.

There is reason then to believe, that the removal of one part of the Norfolk coast has led to the consolidation of another; and has tended to silt up and raise the bed of the æstuaries to such a degree, as almost to exclude the ingress of the tide. In their present state, they are filled to the depth of many feet with ooze, accompanied with fluviatile shells. Gravelly knolls arise, at intervals, to the surface; and banks of shells, partly drifted from the ocean, and partly consisting of those *tellinæ*, *mactræ*, and other genera usually found associating in oozy beds near the mouths of large rivers, are occasionally discovered. After having passed some miles from the sea, the rivers are contracted by the growth and decay of aquatic plants, forming unembanked margins locally called Ronds; and similar recent formations of marshy peat are gradually narrowing the broads. Except under such circumstances, the main æstuaries exhibit no ancient accumulations of peat, no large trunks of trees, or other indications of a freshwater valley. Every thing denotes that their beds were gradually heightened by the deposition of a marine sediment. In this there is nothing remarkable; the operation is daily going on on the Lincolnshire coast, where instances are related of the precipitation of a stratum of mud an inch thick, in a single day. The industry of man enables him to avail himself of this tendency;—the operations of nature are assisted by art, and large tracts of the richest land have been artificially produced from the earthy materials brought by the waters of the ocean. Had we need to travel further than the adjoining county, this article might be extended by reciting remarkable illustrations of the formation of alluvial lands, in the numerous and fertile Danish islands of the Baltic; in the *marsches* on the coast of Sleswick, or in the Deltas on the shores of the Adriatic. A due examination into all the facts by which local changes are accomplished,—whether in the gradual absorption of high lands, on the one hand, or in the progressive emersion of extensive flats, on the other,—in either case the result of existing causes has always ended in confirming the general principle of the permanent residence of the sea at one level, and without diminution, since the deluge. All the apparent exceptions are referable to local and existing causes; as in the cases of coral reefs, of muddy depositions, or volcanic agency, which affect not the surface of the ocean, but elevate or depress the base upon which its waters repose. The balance of these fluctuations leaves the water level where it ever stood: or if any alteration could be perceptible over so extensive an area, it would be an elevation corresponding to the disintegration of the land.

The ground upon which the town of Yarmouth stands is decidedly alluvial. Four distinct processes contributed to its formation. The first may be traced in the accumulation of heavy materials, rolled by the action of the sea; the second in the deposit of oozy sediment from muddy waters; the third in the external covering of sand by the operations of the winds; and lastly, in the rise and decay of vegetable substances.

The wind is a more powerful agent in forming the sandy belts which defend our shores, than has been imagined. Mr. Robberds has overlooked this circumstance altogether, in speculating on the origin of the low lands between Caister and Gorleston. His arguments are, that if the sea retained the same level as when it washed up the banks across this æstuary, it would occasionally still overflow those mounds; and its waters would be capable of sweeping away at one time, what they may have brought at another; for "it is physically impossible that water, even in a state of the most impetuous agitation, should raise any permanent barrier against its own course."

It is no less singular than true, that in the whole circuit of our shores, wherever the substantial barriers of high lands, cliffs and rocks are wanting, except in the cases of retiring unexposed inlets, nature has substituted defences of sand, accumulated by the winds, preserved by peculiar plants, and rarely requiring the assistance of man to render them effectual.

Has Mr. Robberds never rambled by the side of the sand-hills, formed by the actions of the winds, along the coast between Winterton and Happisburgh; or witnessed the remarkable ridges of sand, provincially termed Meals, by which the harbours of Cley, Blakeney, Wells, Burnham and Brancaster, are securely defended from the fury of the northerly gales? These hills are 50 or 60 feet high; they are composed of dry sand, bound in a compact mass by the long creeping roots and fibres of the plant called marram:—*Arundo arenaria* *. To this singularly useful plant the sand-hills owe their consolidation and elevation; it has been cultivated with some care upon our coast, and the industrious Dutch are indebted to its assistance for the preservation of their islands and flat coasts.

On the western coast, where the tides attain a great elevation, the marshes of Pembrey in Carmarthenshire have four or five concentric ridges of similar hillocks, forming as perfect and permanent barriers against the sea as the art of man could execute.

The mouth of the River Ogmoor, in Glamorganshire, presents a singular appearance of desolation at the present moment, through the agency of the wind and sand. Its ancient channel is filled up for two miles; houses are rendered uninhabitable, and sand-hills are raised nearly 150 feet. The mountains which bound the harbour will check the advance of this sand-flood into the interior; otherwise it threatens to overwhelm all the lands which adjoin it; while the squalls of wind, rushing down the steep valleys, occasion eddies, which deposit the sand at an elevation apparently far beyond the reach of such an irresistible enemy.

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* "One of the most valuable grasses for binding the sand of the sea-shore, and raising those banks which in Norfolk, and especially in Holland, are the chief defences of the country against the encroachments of the ocean. *Elymus arenarius*, *Carex arenaria*, and even *Festuca rubra*, contribute to the same end." Smith's English Flora, vol. i. p. 172.

There is no need to multiply instances; and having mentioned these, out of many of a similar description, the comparatively insignificant height to which the sand has hitherto been drifted on Yarmouth Denes (dunes or downs), will scarcely be considered deserving further discussion. At all events it may be stated, since the fourteenth century the operation has proceeded unceasingly, and may at a future period become a formidable evil to that town. It is an historical fact, that part of the ground within the limits of the Burgh is artificially raised. The ramparts round the inside of the walls were constructed in 1663, from " those little sand-banks which the sea and easterly winds had raised on the denes."

It is a well known fact, proved before a committee of the House of Commons during the last and present session of parliament, that the chief portion of the eastern marshes is even now 18 inches to two feet below the surface of the rivers which pass through them, and that the water is artificially kept out by embankments and draining mills. Consequently, were the operations of these to be suspended, the valleys would, even under the present circumstances as to the admission of tides, be overflowed about the same depth as the unembanked Lake of Breydon.

All the tidal waters that proceed up the various streams and diffuse themselves over Breydon Lake, must previously pass through an opening or water-way only about 150 feet wide at Yarmouth bridge; and such are the obstructions so narrow a passage and the bar present to the ingress of the tide, that an eminent engineer has recently reported that the height of high-water above Yarmouth bridge is from one to three feet lower than at the haven's mouth. The average rise of the tide throughout the year at Yarmouth bridge being only three or four feet, the absolute quantity of sea water passing into the interior is therefore very small.

Let us contemplate the effect produced, when an immensely increased volume of water pressed forward, unimpeded, through several wide openings, as in the former state of the Saxon shore. It would be contrary to all analogy to assume that these inlets ever existed upon such an exposed coast, and amidst such moveable materials, without bars at their mouths, like the deep Forths of Scotland, to which they have been improperly assimilated. Nevertheless, a large body of sea water would advance, and be forced, in proportion to the width and depth of those openings and the absence or presence of obstructions, more or less far up the valleys. The waters of wide æstuaries being impelled by the force of the tides from behind, and being restricted in their channels as they proceed by the contracting high grounds, actually attain a considerably higher elevation than the open sea whence they proceed. On the contrary, in narrow entrances, like the haven of Yarmouth, the tidal waters speedily sustain a material decrease in their height; and in this instance, we have seen that the level of Lake Breydon is from one to three feet lower than the ocean, from which it is separated by an alluvial bank not half a mile across. If to the thickness of the bed of ooze be added the difference between its present surface and that of the sea at high tides, we obtain the absolute depth of water which could with any probability be contained within the æstuaries, at the earliest period, before they received any portion of their covering of marine sediment. But there appear no conclusive reasons for assigning a higher level than four or five feet above the mean height of the existing rivers, at any period of which we possess historical records.

Surely Mr. Robberds's etymology of Herringby and Herringfleet is explained to favour a given theory, and must be received with caution. One at least is an evident corruption of compound Anglo-Saxon words, and has no reference to fish, whose habits lead them to avoid shallow muddy rivers.

In Domesday Book, Herringby is written *Har-ing-bei*. Herringfleet is spelt *Herl-yng-flete*; and in a subsequent record we have it *Herl-inga-flet*: the two first syllables being clearly the same as *Herling*, lately written Harling, in Shropham hundred.

About the year 901 the boundaries of the counties and hundreds were defined, and the limits of parishes and manorial jurisdictions were determined. These provincial subdivisions, and even the estates into which they were further appropriated, are carefully registered in Domesday Book. It happens, without any exception, that all the boundaries of the counties, hundreds, and local jurisdictions of this district, are the rivers which wind through the various marshy valleys. It follows, therefore, that these streams had, as early as the year 900, formed themselves channels, adapted to mark the boundaries of property; which channels have continued to our times, with little alteration, except at their immediate outlets.

They were gradually embanked, as cultivation proceeded and the value of land increased. We know that the river which divides the hundreds of Flegg and Happing was embanked previously to 1274, near the Abbey of Holm; for in that year occurred a dispute about the right of fishing from the river's banks.

One mode of estimating the comparative elevation of the waters, is distinctly furnished in the causeways or dams, which were early constructed across the æstuaries. The bridge called Weybrigg, at Acle, and the great causeway connecting with it, were certainly in existence in the eleventh century; and we find that payments were made towards their *repair* in 1101, and succeeding years. This causeway is so little above the present level of the river and marshes, that even in our own times it has been repeatedly overflowed. At any rate, it establishes the negative fact, that no very important change has taken place in seven centuries at a point adjoining the broadest part of the main æstuary, and only eight miles from the sea.

It is stated in a preceding page, that to a limited extent the channels of the Yare and other rivers were wider than at present; evinced by the peaty margins and the deposit of silt in the undisturbed recesses. These circumstances are confirmatory of the reduced supply of tidal waters, and show that the streams have gradually accommodated themselves to the volume of water which they have to convey.

With regard to the arrival of the Danish fleet at Norwich, A. D. 1004, no other change is needed to explain the probability of such an event, than has been accounted for. At that early period of the art of navigation, ships were constructed of little burden and of light draught; and with the advantages of several feet of tide, there could be little hazard in attempting a navigation which even at this day is capable of admitting the smaller description of coasting vessels. Nor could there be much danger under the circumstances, in an enterprize where there was neither a hostile fleet nor army to contend against; and where, on arriving at the capital of East Anglia, the invaders found the inhabitants unprepared for defence, and eager to purchase an humiliating peace.

The *Salinæ*, mentioned in Domesday Book, were chiefly situated on the north shore of the main æstuary, within three miles of its mouth; 39 of them being at Caister, and 30 more in the two contiguous parishes. None occur in the Norwich, Beccles, or Kirkley valleys; and as it does not appear that saltworks were mentioned *after* the Confessor's time, it is probable that the north entrance commenced silting up shortly after, so as to exclude the requisite admission of sea water for such works *.

Some uncertainty prevails with respect to an open communication between the ocean and the extensive watery flat near Horsea. Mr. Robberds's map shows two points by which the sea appears to have penetrated into this flat. Local records are silent upon that head. There is no mention of saltworks upon its borders, or of any other circumstances positively implying such an event. From the remotest period to which we can refer, it has been a branch of the main æstuary of the Garienis, and by this channel the drainage of the district is effected. The soil is composed chiefly of peat, rather than of ooze; the first characterizing the upper parts of a valley, the latter its mouth. Whether by the gradual external wearing away of this coast, the sea approached so near this flat as occasionally to overflow the intervening bank of sand; or whether that bank results from the abrasion of the cliffs to the north, and blocks up an ancient inlet,—there are scarcely sufficient data to determine. The existence, therefore, of those northern channels, although not improbable, must remain conjectural.

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* The value of a Salina was at that time estimated at sevenpence.

There is a mistaken quotation at p. 66, stating that, A. D. 1549, an armed pinnace was sent up the Waveney, as far as Weybread. As the place is called Waybridge in the original authority, this evidently refers to Waybridge, near Acle; that being the most important pass between Yarmouth and Norwich, near which place the rebel army was encamped. Weybread in Suffolk was far removed from the theatre of operations, independently of the physical improbability of any vessel ascending this stream, at least 40 feet above the level of the Yarmouth river, and of passing half-a-dozen water-mills, which interpose in its course. It would not have been necessary to notice this error, but for the circumstance of its being classed with proofs of the altitude of the water, as late as the sixteenth century.

No further comments are suggested by the historical evidence adduced to corroborate the physical circumstances that have previously been investigated, to sustain the theory of an extraordinary reduction in the level of the waters of our æstuaries, and by inference, in that of the surrounding seas.

The result of the foregoing inquiry is opposed to that hypothesis. This inquiry suggests views of cause and effect adequate to the admitted extent of the change, which are briefly these:—

That as long as the ocean-currents set unrestricted into these æstuaries, it was in sufficient quantity to expand over and fill them; the elevation being limited by the height of the tides at the time, and the depth by the greater or less accumulation of oozy sediment.

That there was from the remotest period, through the local causes which have been detailed, a progressive decrease in the volume of this water, and by consequence a reduction, in an equal ratio, of the power to maintain an open mouth.

That the same causes which finally closed the æstuary at Caister, were simultaneously operating to bar the ancient haven at Kirkley, and probably to exclude the sea from the more northerly inlets.

That as soon as the admission of the tide was limited to one narrow and obstructed inlet, the quantity thenceforward was so trifling that "many thousand acres became dry, and in time good pasturage for cattle." With the assistance of embankments, the entire level of marshes became firm land; rich vegetation covered its surface, and the rivers were restricted to their deep channels.

This is the solution of that change whose traces are yet so perceptible; a solution compatible with all the real circumstances, physical and historical, with which the subject is connected. Whilst care has been taken to divest the recital of its apparently exaggerated features, abundant range has been allowed, in accordance with physical probability, for all recorded facts and fairly inferred occurrences.

There exists nothing in the series of phænomena, displayed within the limits of these eastern valleys, that is not repeated on a tenfold scale, in the fens of Lincolnshire and Cambridgeshire. We have there the spectacle of a tract as extensive as the county of Norfolk; once an inland sea, now valuable and productive land;—subjected, in its various stages, to operations similar to those on the shores of the Garienis:—reclaimed, abandoned to the ocean, and again reclaimed;—while the efforts of nature in this earth-forming process, seconded by the labours of man, have been recorded with instructive fidelity.

Assumptions founded on the limited considerations of local operations, of obvious origin and of daily occurrence, are objectionable, because the deductions drawn from thence are seldom applicable to general principles.

The filling up an æstuary by the gradual precipitation from waters charged with alluvial mud, and the consequent exclusion of the tide from its ancient receptacles, offers no better claim on which to establish the principle of a general depression of all the seas in this quarter of our globe, than the actual elevation of several feet, through obvious volcanic agency, of the bed of the Pacific Ocean for a hundred miles parallel to the Andes, proves the general depression of the entire waters of that immense ocean.

The antediluvian shells in the margin of the Norwich valley, prove a local formation only; not the general elevation of the North Sea, subsequent to the deluge. As well might Mr. Robberds have fixed the general elevation of the mighty waters at that point on the Apennines, where are deposited the *Buccinæ*, the *Turbines*, and *Murices*, of which analogous genera are so abundant at Bramerton: or have ascended the scale, and carried its limits yet higher,—where, at the height of twelve hundred toises, upon the Andes, M. Humboldt discovered the fossil teeth of the mastodon, whose remains are also found with the crag shells in our humble valley of Norwich.

It was the common error of the English geologists of the last century, to deduce consequences from too limited premises. Thus our Whitehurst, Woodward, Whiston, Hutton, and other intelligent observers, had each his favourite theory: each saw in the phænomena around him sufficient confirmation of a preconceived hypothesis; each reasoned and speculated from the confined data which came under his own particular observation: and, as it happens in all those cases where research is limited to the evidence of peculiar systems, the facts were not always recorded so impartially as the strictness of geological inquiry demands. Thus, for a time, schools were instituted, the disciples of which saw only through the eyes of their respective masters, and rejected truths which harmonized not with their views. It is obvious that such a process tended rather to confuse, than to simplify and facilitate the progress of this science.

This disposition to theorize has happily decreased, as the number of observers has augmented; while all unite to collect the data, to arrange the documents, and to combine those proofs, whence hereafter will arise some incontrovertible and universally acknowledged principle, by which to account for phænomena at present so inexplicable.

Conclusion.

In connection with the subject which has occupied the preceding pages, it has been suggested as worthy of deliberation, how far causes which have been, and are supposed still to be, in active operation, may lead to injurious effects, at no very distant time, on the internal navigation of this district.

Allowing for a moment the hypothesis of a gradually decreasing elevation of the North Sea to be true, it would be but natural and reasonable to apprehend a corresponding diminution in the waters of these rivers, and consequently the deterioration of the navigable facilities they now possess in a remarkable degree. But the fact, if not made apparent, at least has been attempted to be shown, that no such change in the main ocean has taken place, or is in progress;—that the contraction of those spaces over which the waters once spread themselves, and the limitation of the ancient channels, have arisen from local, independent and obvious circumstances;—and that precisely parallel instances may be at this moment observed in the Thames, the Humber, and some other rivers of this country, which pass through wide alluvial valleys in their way to the sea. That the tides formerly expanded over the whole space between the high lands of Essex on the north, and those of Kent on the south, side of the Thames, it is impossible to doubt, even were it not an authenticated historical fact; for the marshes are still several feet below high-water level; and this noble river is restricted to its channel by artificial means, even within the limits of the metropolis.

The bed of the river Severn is conceived to be gradually elevated by the deposition of ooze, with which its waters are highly charged; so that it has been found expedient, from time to time, to increase the height of its banks, to prevent an inundation of the adjacent meadows. In fact, the river passes through that valley at a higher level than formerly. This was particularly observed, when an interesting section of these stratified deposits was exposed, a few years ago, in forming a culvert. The tides being now artificially restricted in the interior of the country, while the Bristol Channel retains its original breadth, are necessarily elevated in their progress, somewhat in proportion to that contraction.

Not so with the Yare, whose outlet has been remarkably diminished by the combined operations of nature and art: at present this river, and its sister streams the Waveney and the Bure, resemble canals, whose waters are sustained, at a common level and uniform depth, by means of a natural lock or weir at their lower extremity. As compared with other rivers whose embouchure is on a diluvial shore, the tidal waters they receive are remarkable for their purity; and this favourable circumstance is improved by, and perhaps is mainly attributable to, the narrowness of the inlet by which those marine waters find admittance. Mr. Telford observes, in a Report dated 1822, that owing to this purity in the tidal waters, Breydon Lake has so long remained of its present dimensions.

The most serious evil, which for centuries has embarrassed the navigation and occasioned enormous charges upon the inhabitants of Yarmouth and the trade of this district, is acknowledged to reside in the difficulty of maintaining an open haven, of sufficient depth to enable ships of moderate draught to pass over the bar. From the time of Edward III., when the sea deserted, or rather choked up the ancient northern channel, even to the present day, there have been constant struggles between man and the ocean, to preserve an outlet adapted to the necessities of commerce; and the history of these events evince the unwearied industry and the laudable perseverance of the towns-people. In the course of the first two centuries, seven new havens, in different situations, were successively constructed, at average intervals of about thirty years*.

During this period, the greatest efforts were made, and voluntary privations submitted to; levies were exacted and duties imposed, to meet the heavy and oft-recurring charges. Every sovereign, from Edward III. to Charles I., was in turn a benefactor; and contributed by subsidies, by exemptions, grants and beneficial licenses, to the furtherance of these undertakings. Numerous as were the appeals to the munificence of the government, it appears that they were seldom made in vain. For two hundred and fifty years the inhabitants of Yarmouth were burdened with self-imposed contributions: at length they were constrained to sell the bells, plate, vestments and ornaments of their church; to procure letters-patent for general collection throughout the kingdom; and they obtained authority to assess the marsh lands of the eastern valleys, and even to tax property in the city of Norwich. Between the middle of the sixteenth and seventeenth centuries, after five successive havens had been formed and abandoned, above seventy thousand pounds were expended in constructing and maintaining others. Subsequently, the management of the haven and pier affairs has been confided, through the authority of several acts of parliament, to a commission which has employed very large sums in aid of the same works, as appears by public documents, to the amount of several thousand pounds annually. Estimates for further un-

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* The dates of the formation of these havens are as follows:—

The first haven in.........	1347
The second................	1392
The third	1408
The fourth..................	1503
The fifth	1523
The sixth..................	1549
The seventh	1559

dertakings and expenditure have been recently laid before that body, with a view of facilitating the navigable communication between Yarmouth and the interior. For several years past, great exertions have been made by the citizens of Norwich, to accomplish similar improvements, and in particular to obtain the sanction of the legislature to a plan for admitting sea-worthy vessels to pass up to Norwich. It was originally proposed, for this purpose, to amend the existing navigation by way of Yarmouth; but subsequently the design has been suggested and pursued, of entering the sea more to the southward, at the ancient and long-abandoned haven of Kirkley, by means of a lock from Lake Lothing. The expense of such an undertaking is estimated at not less than a hundred thousand pounds.

Thus much I have entered into local detail, merely to show how vastly important the conservation of its inland navigation has been viewed, from a very early period, and through five centuries, by the trading and agricultural interests of this county, and what enormous sums have been and are still proposed to be expended in its service *.

It does not appear that the grand evil of which we have spoken,—namely, the tendency of the sea, under peculiar circumstances of wind and tide, to close up the haven's mouth,—has increased, or that unexpected obstacles have impaired the internal navigation, since the original contraction of the channels. On the commercial and engineering questions of the fitness or inadequacy of the existing works, or the expediency of those which have been projected, it forms no part of the present essay to comment. Those questions have been ably and amply discussed; and the public have lately been put in possession of a great mass of interesting and scientific matter relative to our eastern coasts and harbours.

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* Amounting altogether to about a million and half sterling.

That equal vigilance must be exerted in future, as heretofore, to stem the encroachments of an element so powerful and so difficult to control, is perfectly evident. To second the operations of nature, under certain circumstances, to counteract them in others, and to overcome an evil so formidable that for five hundred years it has defied the efforts of man, requires no small exercise of sagacity. However, there is every reasonable expectation of security against future disasters, from the experience of the past and from the improvements in practical science. At all events, we may contemplate without much apprehension, the calamities which the theory of the declining level of the European seas would teach us to anticipate.

THE END.

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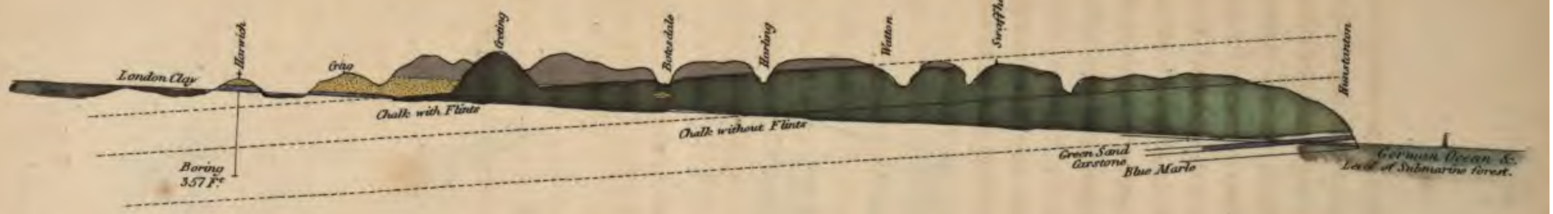
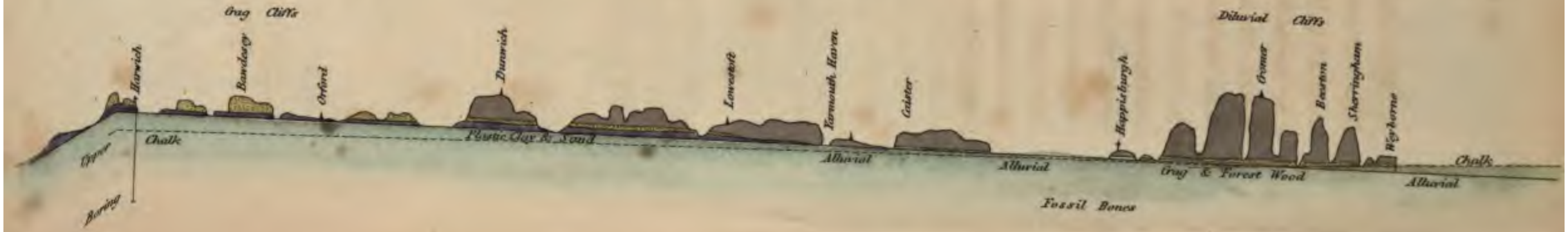
NORFOLK AND SUFFOLK



N.º I — *Interior Section from Harwich to Hunstanton.*



N.º II — *Coast Section from Harwich to Weyborne.*

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ASTOR, LENOX AND
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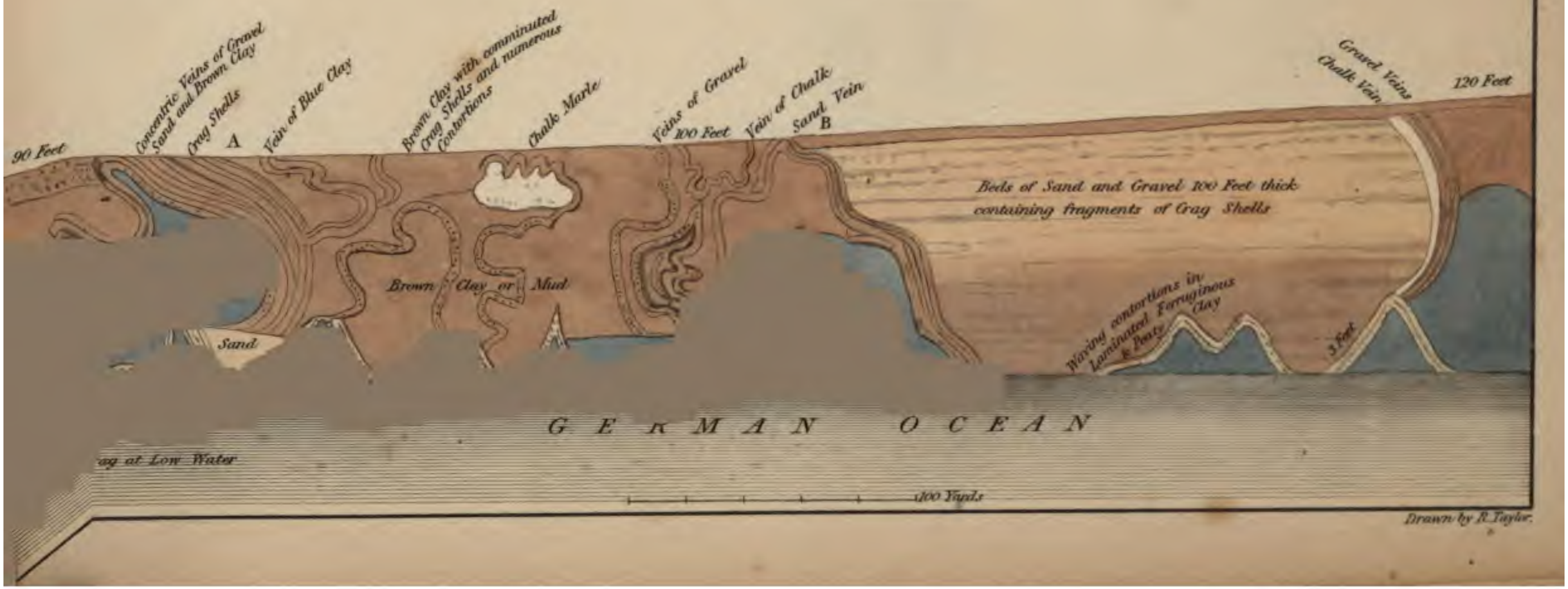
SECTION of part of CROMER CLIFF, showing the remarkable Contortions of the Diluvial Formations.


90 Feet
Concentric Veins of Gravel Sand and Brown Clay
Crag Shells
A
Vein of Blue Clay
Brown Clay with comminuted Crag Shells and numerous Contortions
Chalk Marle
Veins of Gravel
100 Feet
Vein of Chalk
Sand Vein
B
Gravel Veins
Chalk Vein
120 Feet
Beds of Sand and Gravel 100 Feet thick containing fragments of Crag Shells
Brown Clay or Mud
Sand
Waving contortions in Laminated Ferruginous & Peaty Clay
3 Feet
GERMAN OCEAN
ag at Low Water
100 Yards

Drawn by R. Taylor.

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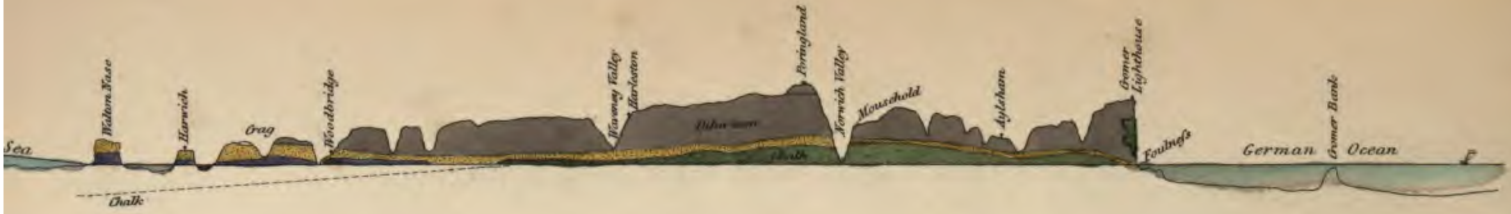
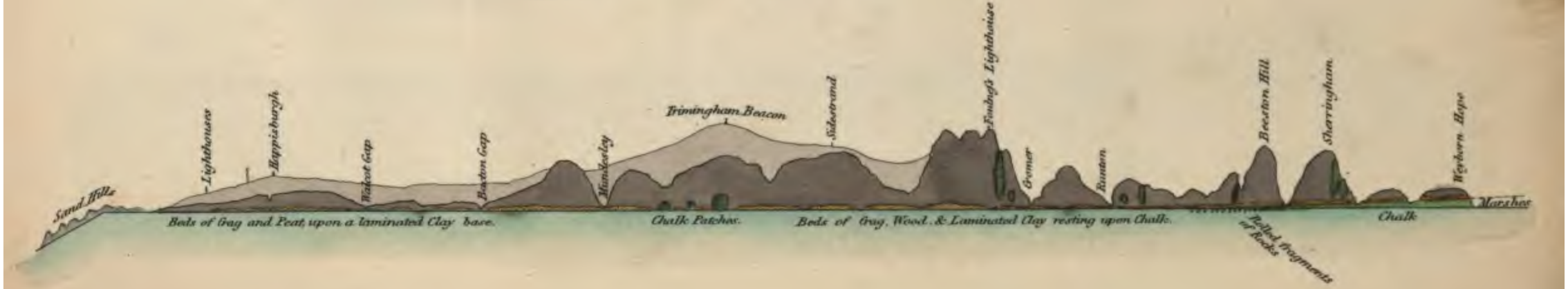
NORFOLK AND SUFFOLK

N°III — Cross Section from Walton Naze to Cromer.



N°IV — Section of the Norfolk Cliffs.



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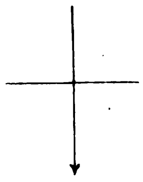
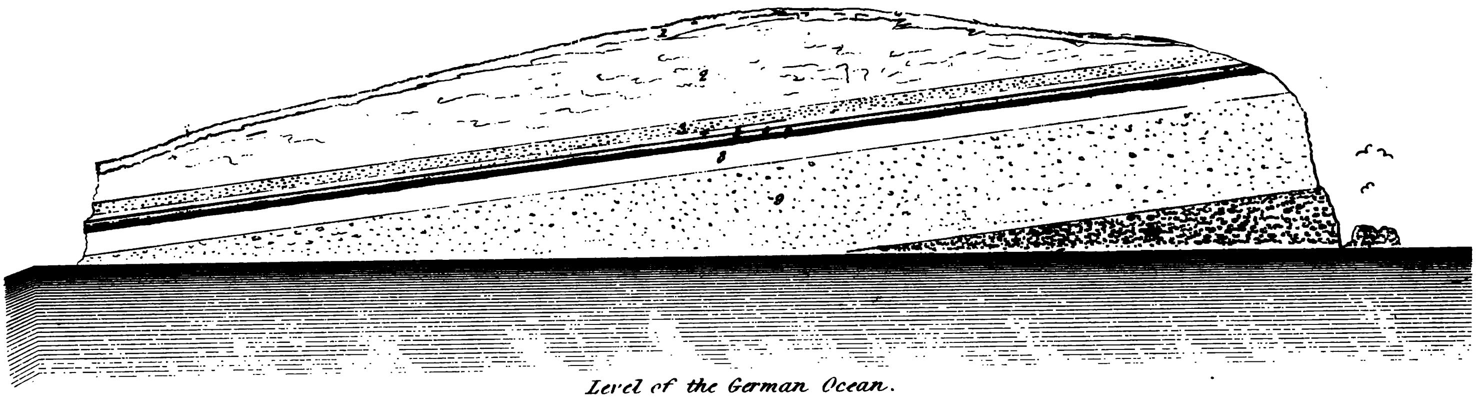


SECTION of the Chalk Strata at HUNSTANTON CLIFF.



Level of the German Ocean.

Drawn by R. Taylor.

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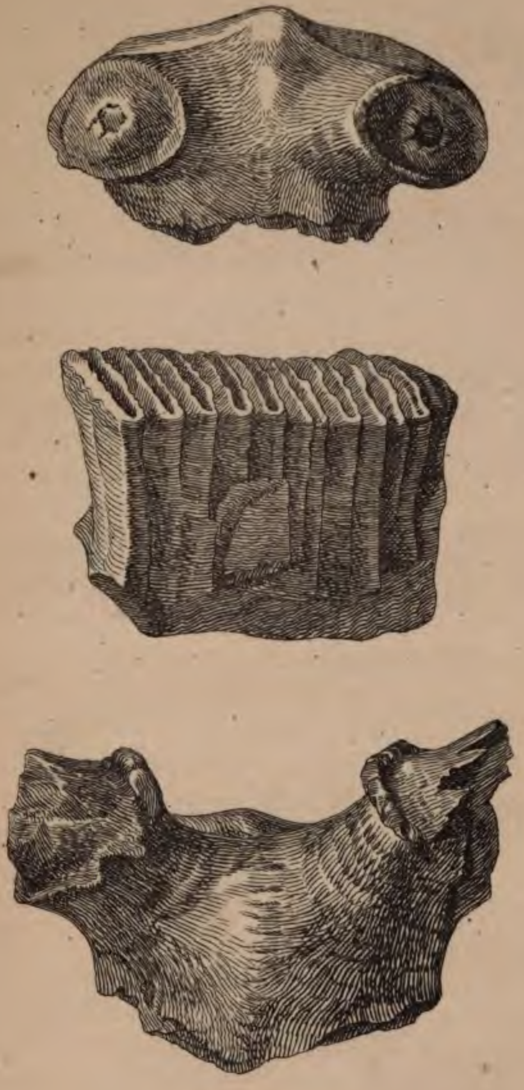

Foſsil Bones found near Cromer.

Drawn by R. Taylor Aug. 1822.

Lithog. S. Pickett St. Strand

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ASTOR, LENOX AND
TILDEN FOUNDATIONS.

On the Natural Embankments formed against the German Ocean on the Norfolk and Suffolk Coasts, and the probable extent of the Crag District; with Remarks on Mr. Robberds's *Letter to the Editors of the Philosophical Magazine and Annals.*

The discussion between Mr. Robberds and myself respecting the natural embankment across the ancient æstuary of the Yare[*], leads to a more general consideration of the process by which that and other similar barriers on this coast have been effected. The mode I suggested in a former communication has been thought defective[†], on account of the difficulty, first, in pointing out a competent agent to rear the fabric, and next, of obtaining an adequate supply of materials. From the argument of the utter impossibility of the sea to throw up a permanent barrier against its own course, I must dissent, as the instances are so numerous to the contrary, that, fortunately for our island, the difficulty is chiefly to select cases in the affirmative. I presume the word "permanent" to be here applied in its limited sense: since we have seen, that not even the solid mountain can permanently withstand the attacks of currents, tides, and impetuous waves, when aided by the winds, and uniting their tremendous forces in one direction.

Such is the tendency of the sea to throw up sand upon that part of the coast we have been describing, that during the last 480 years, as I have shown elsewhere, it has cost about a million and half of money, not merely to keep open a passage for shipping, but to preserve a sufficient channel for the discharge of the united waters of the rivers. It is obviously the opinion of every engineer who has reported on this important subject, that nothing but a continuation of the same unremitting vigilance heretofore exercised, will prevent the closing of that opening for all useful purposes. That this evil is not hypothetical is certain; because it has occurred no less than eight times in the period above stated. A constant effort is going on, on the part of Nature, to stretch the barrier she has previously constructed, entirely across the æstuary, so as either completely to shut out the low grounds from the sea, and to unite, by one continuous sand-bank, Caister with Gorleston, or to divert the current of the river along the base of the Gorleston cliffs. It is counteracted alone by artificial means; by the application of the back waters, and the employment of a forest of timber. An inspection of the Plate fig. 1. will render further details of this locality inexpedient.

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[*] See Phil. Mag. and Annals, N. S. vol. i. p. 351. [†] Ibid. vol. ii. p. 199.

When referring to the agency of vegetation, in contributing to raise those natural mounds around our shores, it was not intended to convey the impression that such elevations were heightened by the accumulation of solid vegetable matter. By the agency employed in these cases, it is scarcely necessary to observe, is meant, that singular disposition of certain plants, the *Arundo arenaria* or Marram* in particular, to collect around them, to hold in a net-work composed of their fibres, stems and branches, the loose and shifting sands;—to bind in one comparatively compact mass, a substance which is apparently little adapted to the important office it is designed to fulfill.

The œconomy of Nature, in forming these sand-ridges, is by no means an uninteresting object of contemplation.

Perhaps by chance a small portion of the *Arundo* fixes itself upon a shingle bed, with scarcely sand sufficient to cover the first root. Rapidly it sends around its creeping stolones, and these serve to arrest some portion of the sands that are constantly moved by the winds. Occasionally the quantity is sufficient, for a time, to overwhelm the young plant: soon it rises with increased vigour to the surface; now appearing not as as one, but as many plants. Again the sand accumulates: layer after layer succeeds; the *Arundo* spreads its shoots still further and higher, and always sends forth its creepers in search of the newly collected sand. By its agency a small hillock is formed, which in time, and by an extension of the same vegetative and accumulative process, becomes a ridge many feet in elevation, or a sand cliff on which the most boisterous wave is rarely capable of encroaching. I had an opportunity of observing an interesting instance of the early part of this process, on the coast of Hampshire, within the last month. Upon a small, newly-formed hillock of sand, in a moist situation, a single plant of the *Arundo* genus had established itself. It had struck out lateral shoots so vigorously, as to induce me to take more accurate note. On measuring one of its stolones I found it to be twelve yards long; and several others, radiating from the original stem, were not less than ten yards each. When thus arranged, their extremities formed a circle, whose diameter was upwards of twenty yards. The joints of the shoots were from six to nine inches asunder. From each or most of these a root was directed downwards into the sand, and one or two young shoots upwards. Calculating them by the number of stolones, it appears that this plant, during a single year, had multiplied itself five-hundred-fold, or had produced what was equivalent, the rudiments of so many distinct plants, independent of the further power of production by seed.

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* From the Gaelic *Muran*, the Sea Reed, or perhaps from the Dutch *Marren* 'to bind'?

I proceed to notice two or three other principal points along the eastern coast, where alluvial deposits have been made under circumstances very similar to those which produced the first we have described at Yarmouth.

At Lowestoft Ness, about seven miles to the southward, the sea has erected a complete series of natural embankments against itself, affording a fair illustration both of the formation of low tracts of land, and of the barriers by which they are defended, (fig. 2). The present extent of land thrown up by the sea, chiefly above its own level, and, excepting in a small

portion,

portion, out of reach of its highest tides, is nearly three miles long, projecting from the base of the original cliff, to the distance of 660 yards, at the point of the Ness. This encroachment has been effected at distinct and distant intervals: its form is influenced by the direction of the currents in the channel or roadstead, and the position of the adjacent shoals; and the lines of growth are indicated by a series of concentric ridges or embankments, inclosing certain areas. Several of these ridges have been formed within the observation of persons now living, the process being precisely similar to that by which I attempted to account for the great bank across the æstuary of the Yare. A rampart of heavy materials is first thrown up to an unusual altitude, by some extraordinary tide, attended with a violent gale. Subsequent tides extend the base, and heap up lighter substances upon its summit. Sand is blown from the beach and fills the interstices. The *Arundo* and other marine plants, by degrees obtain a footing; creep along the ridge, give solidity to the mass, and in some cases form a matted covering of turf: meanwhile, another mound is forming externally, and by the like process rises and gives protection to the first. Occasionally the sea forces its way through one of these external and incomplete mounds, but it is singular to observe how soon the breach is repaired. After a while, the areas inclosed by these concentric embankments become pasturage. The marine plants are succeeded by a better species of herbage, the quality of which improves in each successive area, as step by step we approach from the latest to the earliest formed, at the base of the ancient cliff. Become sufficiently firm to support buildings, they are now occupied by numerous dwellings and offices, where it is recollected the sea formerly flowed; the change being effected not through the depression of its level, but from the obvious operations I have traced*.

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* The mouth of the æstuary of Lake Lothing was finally closed by an embankment about the middle of the 17th century, with a view to completely exclude the irruptions of the sea into this valley: the expenses of this work were defrayed by a levy on the lands which were thus saved from occasional inundation.

About seven miles further south, another Ness is formed, at Covehithe Point, and is about half the extent of the last described, (fig. 3). Here are five principal concentric ridges, four of which are now occupied by the *Arundo arenaria.* This Ness has also materially increased in our own times, and presents the same characters as the last. It is stretched across an ancient inlet of the sea, resembling Lake Lothing, or the Yarmouth Æstuary, on a reduced scale, and forms a complete barrier to the entrance of the sea into a low valley which is partly occupied by a small fresh-water lake.

The drainage-water of this valley is discharged by means of a sluice carried under the shingle bank.

The drawings which illustrate this and Lowestoft Ness, are copied from my surveys of this coast in 1825-1826.

Proceeding along the coast about two miles, we perceive the same circumstances repeated on an enlarged scale in the natural embankment across the Valley and Broad of Easton.

The other sketch (fig. 4.) contains a remarkable illustration of the power of the ocean to form alluvial barriers, and to block up the outlet of a considerable stream. It would appear on an examination of the site, as well as from a consideration of the map of the district, that at some remote period the river Alde entered the sea at Aldborough: that a repetition of the process which diverted the mouth of the Yare four miles to the south, effectually barred the ancient outlet of the Alde, and transferred it to a point no less than ten miles to the south-west; where, being reinforced by the waters of a second river, it enters the sea, in a line nearly parallel with the coast. The external ridge of sand forming Orford Ness, on which the lighthouses are erected, has a strong resemblance to those we have before described, and stretches round so as to form a complete bulwark to the low lands between Aldborough and Hollesley.

A great accumulation of blown sand has formed parallel ridges and marram hillocks, and occupies an area extending from Felix Stow Cliffs, about two miles to Languard Fort, near the mouth of the Orwell. On the south side of Harwich, sand heaps are gradually overspreading the London clay and alluvium of the low lands, and must be derived from depositories at some distance.

It is to be observed that the progress of the sand in covering the newly-formed ridges, and also of the plants which follow that operation, particularly in the three first instances, is from the north, towards the south. At Lowestoft, the sand hillocks gradually decline from the Corton extremity towards the Ness, from nearly twenty feet in height at first, to a few inches over the shingle. The same at Yarmouth, where the high sand-hills decrease from Caister southward, and cover (as the engraving exhibits) scarcely one half the entire bank. With regard, therefore, to the origin of one large portion of the blown sand, it is perfectly obvious that it has travelled southwards from the great depositories in the cliffs and hills, situated to the north of these points; other portions are continually added by that which is drifted by the wind from the beach, and is retained by the plants which appear to be designed to perform that particular office. It is also obvious that these embankments commence at their northern extremities.

The process which has been detailed, is not hypothetical, nor has it been coloured for the sake of harmonizing with a favourite theory; it is the result of some years attention to the circumstances which, requiring very little of the assistance of man, have formed those bulwarks around our coast that rival in stability many of his boasted works.

One word as to the source whence the materials are derived, which Mr. Robberds conceives inadequate "to produce an average elevation even of one inch," over the peninsula of Yarmouth.

It is impossible, when considering attentively the ever-shifting bed of the German Ocean; the enormous extent of its shoals; the multitude of its sand-banks; the powerful tendency of the north-east winds, and the great tidal current from the same quarter, towards this part of our coast, not to feel assured that ample means for the formation of other banks and alluvial headlands are readily at hand, wherever and whenever local causes give direction to powers of such prodigious magnitude. To elucidate this opinion more fully, we are enabled to refer to the estimates made by Mr. Stevenson, (a civil engineer of great eminence and accuracy,) from a vast number of observations and comparisons on the dimensions of the sand-banks in the German Ocean. The result of this computation is, that their average height is about 78 feet; and the aggregate cubical contents of these immense collections of debris is equal to about 14 feet in depth of the whole North Sea; or to 28 feet in elevation, over the entire area of Great Britain! Let it not be asked then, whence is the material to be derived sufficient to raise a bank of a couple of square miles in area, on an exposed part of the shore of the same ocean, half-a-dozen feet above its level?

In a former article I accounted for the gradual exclusion of marine waters from the æstuaries, and for the silting up of the greater portion of the basin which these waters once exclusively occupied. In this view, the assistance which the process received from the alluvium of the adjacent high grounds, the deposits by land-floods, and the final covering of peat, was estimated to the utmost probable extent of those contributing causes. It is agreed that a solid substance has been substituted for a fluid; the surface of which solid substance, including these accretions, is ascertained to be *below* the level both of the adjacent rivers and of the ocean. Those ancient receptacles, formerly filled with water, are now occupied, to the depth of from 10 to 20 feet, with that description of deposit common to all rivers which pass through a diluvial country, and which open upon a coast whose soft and moveable base is continually affected by the waves. The original arms of the sea are now contracted into streams, which receiving but little accession from the tides, are well adapted for conveying the upland waters, and for the passage of a valuable internal trade. Some of the small lakes have been drained, and partially converted to pasturage in our own days: the margins of the Broads are gradually contracting; even Oulton Broad, which has been thought an exception, is unquestionably diminishing through the formation of peat, which stretches by slow but perceptible degrees over its retired recesses. That Lake Lothing and other similarly circumstanced lakes are the last to silt up, is mainly attributable to their having now no currents loaded with muddy particles passing through them: they have thus been preserved from one of the most active agents in filling such reservoirs. From the earliest period there evidently existed a tendency to deposit oozy matter in the valleys, which tendency was materially increased, when, by the subsequent operations of nature, the outlets against the sea were narrowed. Notwithstanding the calculations on the relative specific gravities of earth and water, which, without a due consideration of all the circumstances, have been set in array against this hypothesis, I am satisfied that the bottoms of the valleys have been raised through such an agency. Against all the arguments which ingenuity can devise to the contrary, must be set the simple truth, that the process has gone on, to a considerable degree, from time immemorial, on various parts of this and other shores; and that it is still going on, and may be daily witnessed, to the fullest extent that my suggested system demands. This tendency of turbid waters, when in a state of comparative quiescence, to deposit the substances they hold suspended, is converted to the benefit of the land-owner in abundance of instances; some of them even on the coast of Norfolk; and, in the words of one of the parties, has proved a mine of wealth to those who have availed themselves of it. An instance of undoubted authenticity may be mentioned, in the formation of 1600 acres of valuable land, within the last three years, by Colonel Cheyke, of Rawcliff, near Thorne, in Yorkshire. It was accomplished by the process of warping; that is, by inclosing a given space, upon which the turbid waters of the River Ouse precipitated their silt. The first portion of the land so inclosed consisted of 429 acres, "on the surface of which was deposited, in one year, a fine alluvial soil of the average depth of three feet[*]." This new land was let off at not less than 35 shillings per acre; and the gold medal of the Society for the Encouragement of Arts was awarded to the proprietor. Subsequently, above 1100 acres more, in two portions, have been formed; and in a letter from that gentleman, in 1825, it is stated that he obtains a deposit of *from three to four feet in one year*, upon that area[†].

That an average accumulation, to the extent even of a hundredth part, was required for the formation of the low marsh lands in the eastern valleys, it is unnecessary to conceive; but it is evident that, during the long lapse of ages, such a system was slowly performing by nature, under circumstances favourable to the operation.

In proportion as the entrance for the tidal waters was gradually restricted, and their escape was impeded, did the æstuary of the Yare remarkably resemble one of those large artificial inclosures which are embanked for the purpose of warping. Had an engineer, in remote times, projected the conversion of this once extensive waste of waters into a tract of valuable land, as it now exists, his principal operations would assimilate to those which Nature by degrees performed without his intervention. Were those natural barriers which have interrupted the entry of the great body of water, removed; were our æstuaries again emptied of the ooze and alluvium which have filled them,—the same circumstances, making reasonable allowances for the interposition of man, would be renewed; the waters would again flow up to the walls of Norwich, as high and as freely as they ever did; the same system of obstruction and silting would re-commence; and finally would re-conduct to the same phænomena as are at the present moment exhibited[‡].

There

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[*] Trans. Society for the Encour. of Arts, vol. xliii.

[†] I am informed, that upon the spot where the new Assembly rooms and many houses are standing at Hull, persons recollect to have seen ships of 200 tons burden floating.

[‡] One fact, adverted to in agricultural reports, and not wholly to be over-

There are strong reasons for considering that the other æstuaries (whose openings are sketched in the plate,) were also consolidated by the like influence.

The proofs, physical and historical, having been scrutinized with caution, and as Mr. Robberds is pleased to add, with candour, it would appear that the depression of the sea, to the extent assigned, is far from a necessary consequence deducible from that evidence. It has been shown* that the bed of marine shells, at an elevation of 40 feet, alleged to be similar to existing races in our seas, and marking out the line of an ancient beach, belong chiefly to non-existing species, and to the highest in the series of anti-diluvial formations†. The circumstances relating to these testacea, on which much stress was laid, and which probably suggested the first hints whereon to found the hypothesis, not being again adverted to, it is not unfair to infer are abandoned.

We descend, therefore, at one step to the level of the salinæ in the valleys, for there are no intermediate horizontal beds of shells and marine exuviæ, which, on the theory of the declining waters, must necessarily have occurred and be more or less visible, like the margins of those ancient lakes whose surfaces have progressively fallen by the wearing down of the barriers at their outfall. None of the marshes, at the points where the salinæ mentioned in Domesday are conceived to have been situated, are elevated so much above the level of the sea as to be inapplicable to their original purposes, were not the mouths of the æstuary, as I endeavoured to explain,

overlooked in an inquiry like the present, is, that in the great Marshland district of West Norfolk, those parts which are situated the most remote from the sea, and were the earliest inclosed, are on a *lower* level than those which were reclaimed at a subsequent period.

[*] Phil. Mag. and Annals, vol. i. N. S. p. 282.

[†] An appearance similar to the Bramerton shell bed is repeated on the banks of the Thames, in the great and well-known depository of testaceous remains, 60 feet above the level of that river at Woolwich. Here also observers have not been wanting, to speculate on the apparent subsidence of the waters: yet the same stratum sinks beneath the clay under London, and is intersected in the Tunnel at Rotherhithe, 40 feet *below* the surface of the Thames.

filled

filled up so as to exclude an adequate supply of salt water *. The levels, recently taken by various engineers, prove that the rivers in their progress thence to the ocean have little or no fall: it is well known the marshes for many miles from the sea are below the levels of those rivers; and in the evidence on this subject before the committee of the House of Commons, it was deposed, that on the occasion of the sea breaking through Lake Lothing, 35 years before, it covered this entire level of marshes to the depth of 3 to 3½ feet with salt water.

Domesday-book, therefore, would seem to present us with a collateral proof of the permanent level of this sea; and the circumstances of the salinæ will not, on examination, be found to strengthen the contrary opinion so much as was anticipated. Without dwelling further on this head, it only remains to be noticed, that some caution is to be observed in determining their real localities; because the boundaries of several parishes, enumerated in that ancient document, not only frequently stretch to a remote distance from the villages to which they appertain, but it is of common occurrence in this district that detached portions belong to parishes that are situated many miles in the interior. The level tract of marshes between the Yare and the Waveney, opposite Reedham and extending to Breydon Water, contains no less than nine instances of this intermixture, some of which are detached ten miles from the main parts of their parishes. Local knowledge, in inquiries of this kind, is often desirable, to explain many circumstances otherwise obscure, and irreconcileable with probability.

Respecting the hypothesis of the general subsidence of the German Ocean, I offer no other opinions than may be inferred from the review of the facts which are intimately connected with this investigation; and from a previous remark that "if

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* It is not essential to a saltwork that any considerable depth of sea-water should be within command; the quantity required is uniform, but not large: I believe about 10 inches deep in the reservoirs, and 1½ to 3 inches only in the pans. The writer has recently examined, with some interest, the salinæ on the Hampshire coast. They are more numerous than on any other part of our shores, and extend from Lymington, westward, three or four miles.

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any alteration could be perceptible over so extensive an area, it would be an elevation, corresponding with the disintegration of the land." I was not then aware of a paper which was read before the Geological Society of London in 1816; before the Wernerian Society of Edinburgh in 1820, and published the same year in the Edin. Phil. Journ., entitled "Observations on the Bed of the German Ocean or North Sea, by Robert Stevenson, Esq. Civil Engineer*." This treatise is announced as the result of much personal observation, and considerable professional experience of the eastern coast of Great Britain. Its object is to prove "a great change" in the level of the German Ocean; not that it has fallen, conformably with the views of Mr. Robberds, but that it has *risen*, and continues slowly to rise. The cause is traced to the elevation of the bed of that ocean, by means of the vast increase of alluvium, the wearing away of cliffs and headlands, the reduction of high grounds, the debris of mountains, the decay of vegetable and other organic substances, and the mud of rivers. Mr. Stevenson has founded his reasoning on the consideration of a long series of observations; but it would be unfair to institute any comparison of his hypothesis with that of Mr. Robberds, as the data which have influenced the opinion of that gentleman are not before us. The circumstance is chiefly introduced to show to what opposite conclusions the ablest advocates of truth, science, and candid inquiry, will not unfrequently tend, and consequently how essential to geological speculations is the previous collection and strict examination of facts.

It will be remembered that the subject of debate was, not so much the level of the ocean, as the validity of the proofs contained within, and adduced from, the district under consideration, and an examination of those data which were urged as strong indications of the gradual depression of the waters. Possessing much local acquaintance with the field of inquiry, I entered into the discussion with some confidence; and the

[*] Edinb. Phil. Journ. vol. iii. art. V.

evidence being unsupported by facts drawn from a wider range of observation, the investigation appeared, as indeed it professed, restricted to this district peculiarly.

When in pursuance of the plan sketched by Mr. Robberds, the proofs selected from other shores and from more distant regions are arranged, we shall possess better and more abundant criteria by which to form our judgement: a more extended and interesting field will be opened to our contemplation, and the opinions of the author will be more satisfactorily developed.

I shall not weaken the interest which a consideration of the prominent features of this discussion has created, by combating minor points of difference; being unwilling to appear too tenacious in subordinate details. I am well content to leave it to the decision of those, whose judgement in matters of science we are accustomed to respect. Whatever that decision may be, we shall have had the mutual satisfaction of contributing, through the medium of an amicable controversy, and apart from its speculative portions, to a more accurate knowledge of the physical circumstances of this district.

By

[It is interesting to trace the origin of certain local terms, and to observe their connection with the Northern maritime nations. Thus the *Meals* or sand ridges on the north coast of Norfolk evidently have their name from the same source with the Teutonic and Islandic *mal*, Swedish *mölja*, Dutch *moeilje*, a pier or mole-head, Ang.-Sax. *mæl*, Germ. *mahl*, a boundary.

It is only necessary to look into the map of Norfolk to perceive the great practical utility of these natural moles in guarding the adjacent harbours from the surf of the North Sea. They consist of five principal *meals*, which protect the harbours of Cley, Blakeney, Wells, Burnham, and Thornham, and much resemble works which are artificially constructed, to answer a similar end, on various parts of the European coasts. Through the facilities afforded by these defences, to ships engaged in the coasting trade, the North-west part of this great agricultural county is enabled to export a considerable portion of its produce to the London and Northern markets, and occasionally these minor ports have even an advantage over their great rival Yarmouth, when shipping are detained by the bar at that haven.

The etymology of *Marram* has been mentioned in a previous note.

The Rands or Ronds, described at p. 33 as being the spaces between the rivers and their embankments in these valleys, derive their name from the Teutonic *Rand*, an edge, brink, or margin. Bishop Wilkins says that *rand*

means

By adopting in some instances a nomenclature which appears applicable to the case, I am certainly open to the charge of adhesion to the modern school of geology. Most English geologists have, for the sake of convenience, but without thereby pledging themselves to individual speculations, agreed on the principal terms by which to distinguish certain formations; and amongst others, I am well content to employ these terms in the sense in which they are generally applied.

But still, in the investigation into which he has entered, "Mr. Taylor has surrendered his judgement to authority," p. 276. Here I acknowledge no authority but that of my own personal observation. The ground was probably not untrod

means flank, in which sense it is applied to a part of beef and to the welt of a shoe. Were I to seek more southward for an illustration of the term, as applied to localities, I think it might be found in the etymology of *Randa*, in the department of the Valais in Switzerland.

The appellation Denes for the sandy alluvial tracts next the sea on the Norfolk coast, corresponds with *Dunes*, *Duynen*, used by the French and Flemish for those on the opposite coast. Thus Duynkerke (Dunkirk) derives its name from the church originally founded on the Denes on the first establishment of that town.

The etymology of Breydon is more doubtful; perhaps from its contiguity to the Denes, like the Flemish Bredene near Ostend: or from the Saxon *Bradan* or *Brædene*, broad:—the Broad *par excellence*.

Mr. Robberds has completely traced the origin of the Garienis or Yare, to the illustration of which I contributed the Welsh names of two rivers, the *Garrw* and the *Garan*; and it is suggested whether the ancient hamlet of *Carrow*, situated near the junction of the Yare and Wensum, be not derived from the same Celtic source.

With regard to the Wensum, I could wish to see the doubts respecting the extent of this river below Norwich removed, and agree with Mr. Robberds, that it ceases at its junction with the Yare near Carrow. In order to meet any legal technical difficulties in nomenclature, it is now usual to style the principal stream, "the River Wensum, otherwise Yare." A friend suggests that Wensum may be connected with the British *Gwent* or *Went*, a chief city or head-quarters.]

Note.—The Maps in the Plate are on the following scales: Fig. 1. at 1 mile to an inch; fig. 2 & 3. ¼ mile to an inch; fig. 4. 2 miles to an inch.

by geological observers; but their views, whatever they might be, were unrecorded*. Unshackled by precedent or by conflicting systems, I have demonstrated the general continuity and extension of the crag formation, beyond the possibility of doubt in my own mind, or, I think, in that of those who may follow up the investigation. I have not, "because there are beds of shells at Harwich and others at Cromer," decided from that circumstance merely, that these must be extremities of the same strata; but I have, step by step, with no little labour, during the last seventeen years, examined and identified much of the intermediate area; and, in reviewing the data by which I have been governed, have no more distrust of the fact than of the prevalence of clay in Essex, or of sand on Bagshot-heath.

But I have nowhere asserted that the exuviæ are uniformly continuous, or even that the beds which contain them are wholly so. On the contrary, those inferences are expressly guarded against, when remarking that a leading characteristic of the shells is, "that they are by no means diffused in equal numbers and proportions, but occur, at intervals, in groups and genera;" and that wherever the chalk or earlier formations rise above the general level of the crag, that deposit would then be absent,—circumstances which find a parallel in all the soft strata above the chalk, from the plastic clay upwards. It was further observed, that the upper marine deposits in some cases appear to surround the bases of chalk eminences, which then "present the appearances of tongues or promontories, protruding into the crag" district, and "account for the occasionally apparent absence of that formation," and for the sinuosities of its outline. This is also of common occurrence in the later deposits, whose boundaries are much, but not entirely, influenced by the configuration of their chalk basis.

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* In justice I ought to except the name of William Smith, the first to depict the strata with which the surface of this island is diversified, and the first to discover and apply that remarkable rule by which their identity is established.

That the organic remains, peculiar to certain strata, are sometimes unusually abundant and sometimes absent from their matrices for considerable intervals, we might appeal to the experience of every practical geologist, who has traced in detail any of our superior formations, such as the plastic and London clays, and indeed, some of the indurated strata, such as the lias, (lyers?) the oolites, and the calcareous sandstones. Yet the identity of these strata is in most cases satisfactorily established. So also with the crag beds, which may be frequently seen in the open face of a cliff or excavation, in parts abounding with fossil shells, in others devoid of them: sometimes suddenly ceasing; sometimes gradually thinning off; but the continuity of the matrix is still apparent and unquestionable. Perhaps there is no formation in the entire range of superior and supermedial strata, whose organic accompaniments are not unequally distributed, and at times wholly interrupted.

I am perfectly aware, from personal experience, how well this observation applies to the deposits in East Norfolk, and how often the sand and gravel beds are either without fossils, or contain only occasional indications of their existence. But enough has been seen to prove that the lower beds on which the diluvium and "the ante-human gravel" repose, may be classed with the highest known marine formations.

In most of the instances where the crag is exposed in the Norwich valley, the chalk hills rise higher than the shelly beds, and, of course, the latter never penetrate into the older formation. Consequently, the extent of these beds, internally, would be governed by the distance at which the plane of the one is intersected by the slope of the other. The principal excavation is that at Whitlingham, which I understand has been worked from time immemorial, and the face of the chalk hill has been removed at least 100 yards. Yet I have collected, and now possess, from this perpendicular face in the beds overlying the chalk, numerous specimens of testacea. In to all parts of this excavation, intermediate between the chalk

and

'and sand, was a bed, about a foot thick, of coarse angular flints, much resembling those which interpose almost uninterruptedly between the plastic clay and the chalk, and containing shells. The deposits above the chalk at this place have also produced remains of the elephant, mastodon, deer, whale, and small fish*.

Mr. R. ascribes the presence of extinct species of shells to their accidental admission; and with equal facility the animal remains, of which I enumerated four or five genera from a variety of localities (although I am somewhat humorously made to announce a solitary specimen,) are likewise fortuitously introduced from some "earlier" stratum.

From the observations I have been enabled to make, both in the Norwich beds and in distant parts of the formation, the animal remains are commonly blended with the mass, or in the detritus immediately overlying; by which circumstance we may conjecture that they were partly of contemporaneous and partly of subsequent origin, with the testacea.

The area occupied by the crag extends, with few interruptions, from the borders of Essex, along the eastern side of Suffolk, over an average width of about seven miles, contracting toward the north, and partially concealed there by diluvial clay. In this southern or Suffolk portion the testaceous exuviæ are astonishingly abundant, and are applied as a valuable manure. Further northward we distinctly resume the traces of this deposit: its beds then become thinner; its productions less abundant and more covered with debris; until, at the distance of 100 miles from its commencement, it wholly ceases, and the chalk attains a superior elevation. Its south-west boundary, in both counties, is irregularly defined, amidst the diluvial clays and the interruptions of older formations.

Viewing all the circumstances, the general agreement of the organic remains, the evident connection of the main Suffolk portion with that on the Norfolk coast, and in various parts in the interior, I am unable to draw any other inference than that they are parts of one contemporaneous formation, from whence there appears no adequate reason for excepting the Norwich extremity.

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* I have the authority of an excellent comparative anatomist for stating, that to my list of the animal remains discovered in the diluvial clay of the Waveney Valley, may be added the crocodile, the plesiosaurus, ichthyosaurus, squalus, and balistes.

We have seen that, while constantly retaining some characteristic features, this formation exhibits rapid and frequent fluctuations; that no neighbouring portions are precisely alike; that at every hundred yards it presents novelty of arrangement; in structure varying from fine sand to coarse gravel or ferruginous conglomerates; in thickness, from a few inches to fifty feet; in the presence or absence of fossil substances, and in the nature of those accompaniments. In the eastern valleys the proofs do certainly appear in sufficient abundance to establish their geological conformity with more distant portions of the district.

With this conviction, can I hesitate between admitting a system opposed to these facts, and apparently derived from the inspection of a few excavations near Norwich, or following the guidance of a judgement formed from an investigation extending over five hundred square miles?

With regard to the orthography of Heringfleet, I would only add that I find it Herlyngflete more than thirty times in various ancient records besides Domesday Book[*]: and that

many

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[*] It appears to have been thus written, with little variation, from the 11th to the 16th century. The authorities relied on in the *Index Monasticus* for the ancient orthography are, Domesday Book A.D. 1086; *Rotuli Hundredorum*, 1273, where it occurs 19 times: *Taxatio Ecclesiastica*, 1291, 4 times: Charter in Blomefield, 1300: Grant in *Notitia Monastica*, twice: *Inquisitionem post mortem* 1347 to 1377, 5 times: *Rotulorum originalium in curia Scaccarii* 1350. Heryngflete occurs but twice in these records. In searching for the origin of the syllable *Herl*, it will probably be found to import the same as when used in Herleston and Herling in Norfolk; Herlington, Lincolnshire; and Herlingdon, Bedfordshire. *Flete* is a word of very common use in the Norfolk marshes, being applied to those embanked drains which conduct the land-springs or upland waters across the marshes to the principal rivers. There are half-a-dozen *Fletes* immediately contiguous to the parish of Heringflete.

Whatever be the derivation of Haringby, it appears to resemble several other places which occur in early records; thus Haryng in Leicestershire; Haryng, Devonshire; Herring, Bedfordshire; Haryngswell, Suffolk; Haryngsbury, Essex; Haryngey, Middlesex; Haringworth, Northamptonshire; Heringham, Kent; Haryngton, Durham; and Heringrove, Gloucestershire.

many inland towns have their names compounded of Hering, Haring, and Herling: also that the word Fleet signifies a river or watercourse (which is its present use in the Norfolk marshes) as well as an æstuary.

A recent opportunity of examination has strengthened the opinion that the large bouldered fragments of primitive rocks on the coast are derived from the Norfolk diluvium. They are not unfrequently seen in pits or upon the surface many miles from the sea, particularly in the neighbourhood of North Walsham and Aylsham. The circumstance is referred to chiefly, because I am quoted, perhaps inadvertently, as conceiving these rounded masses to be drifted to our shores by currents.

Mr. Robberds's unabating adherence to his views of the marine exuviæ has placed him in a dilemma. In arranging his proofs of the former altitude of the sea, the most prominent, the most irresistible corroborative fact insisted upon, was the complete identity of these exuviæ with "those of the testaceous molluscæ of the German Ocean." This fact was too momentous to pass without investigation. The result is unfavourable to the hypothesis which hinges upon it, and then such an inquiry is deprecated as too minute;—the eye of Science is too microscopic, and the discrepancies it discovers are "of no account in determining the character and antiquity of any formation." Natural History is appealed to, as supplying the proofs of an alleged fact: but as the volume of Nature is not sealed, the page is again opened, the reading is extended, and we then perceive truths which conduct to far other conclusions. Let the testimony which has been summoned, be applied, not in part, but to its real extent: let the evidence be taken in its absolute amount, as the scrutiny of science rigidly demands. If that species of evidence be as estimable as practical observers have declared, the process of collecting it must not be despised. If we would draw inferences from the consideration of natural phænomena, we are not at liberty to refuse the salutary application of those tests by which, in the physical sciences, any theory must stand or fall.

I will not do such injustice to Mr. Robberds as to suppose (Phil. Mag. p. 252, 253) that he upholds the exploded doctrines against the extension of knowledge on account of its occasional misapplication;—the liberality of his mind is too widely known to give rise for a single moment to such a conclusion. I am quite disposed to agree with him, that investigations into subordinate detail have, in some cases, been pursued to an unnecessary and almost trifling minuteness, until the primary object of pursuit has been lost sight of, and that there may be in these instances a tendency to overrate the value of such details. We might go further, and assert that the progress of science and its legitimate objects are not facilitated by the prevailing disposition to create endless subdivisions, to perceive petty distinctions, and to bestow new names; by all which our elementary books are increased in bulk and crowded with interminable varieties and synonyms, through whose mazes the perplexed student is doomed to wander. These are inconveniences from which few branches of natural philosophy are exempt.

But let us not, on the other hand, underrate the aid which geology derives from the collateral sciences. The cultivation of any one department leads insensibly and unexpectedly to the development of another, and the truths which the sciences establish cannot with safety be rejected or defied. By the free communication and the ultimate concentration of these truths, we shall be conducted with slow, but with less erring steps, to the more obscure and sublime parts of the system.

#=4 THE END.

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Illustrations of Natural Embankments, on the Norfolk and Suffolk Coasts.

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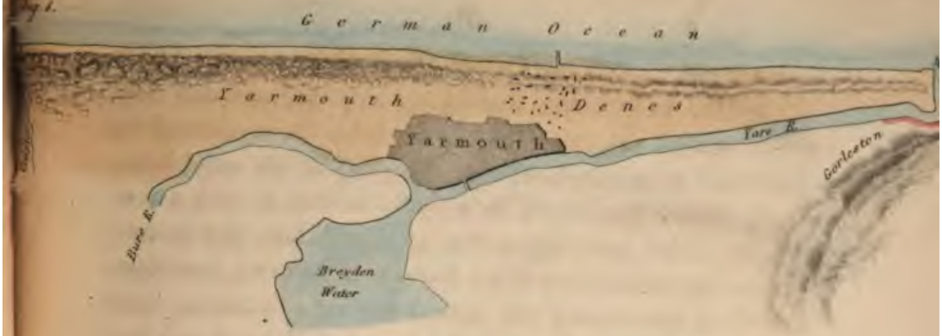

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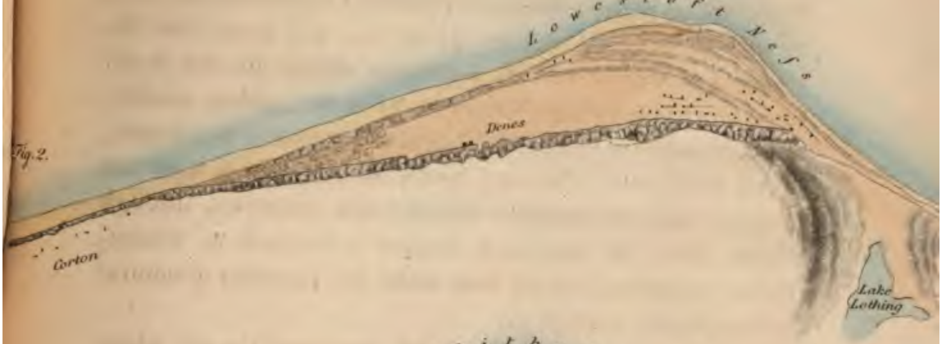

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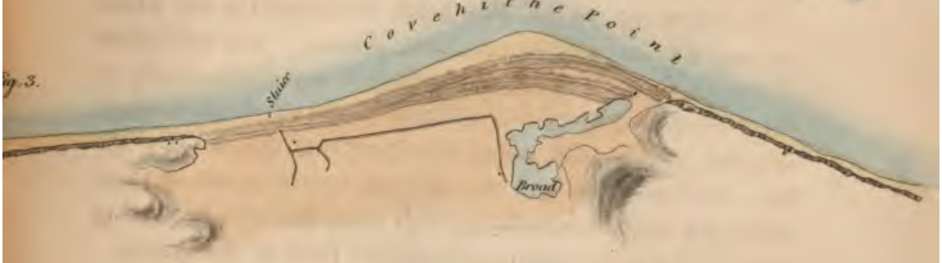

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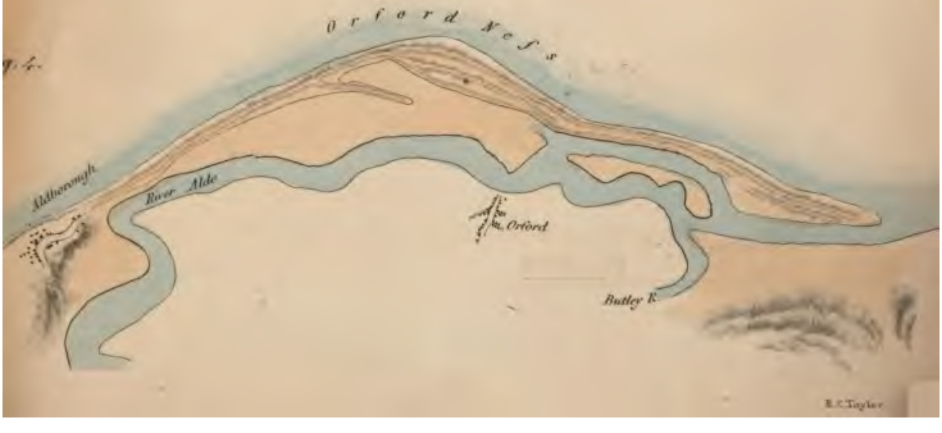

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